



MAY 1, 1973



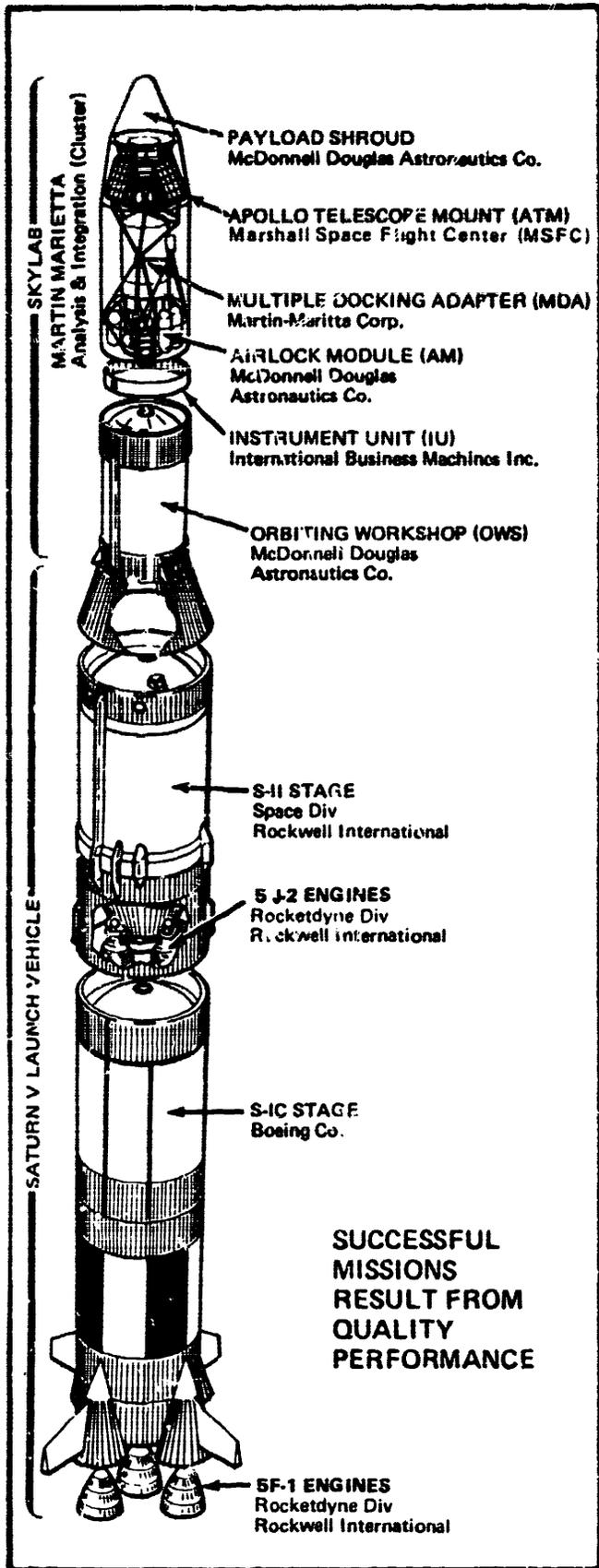
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# SKYLAB

ILLUSTRATED CHRONOLOGY

1962 ★ 1973





MHR 9  
A&PS-MS-H  
May 1, 1973

**SKYLAB ILLUSTRATED CHRONOLOGY**  
**1962 – 1973**

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## INTRODUCTION

Skylab is America's first experimental space station. Dwarfing previous manned spacecraft, this huge cluster of hardware includes roomy living quarters and laboratories equipped with complex scientific equipment for three astronauts.

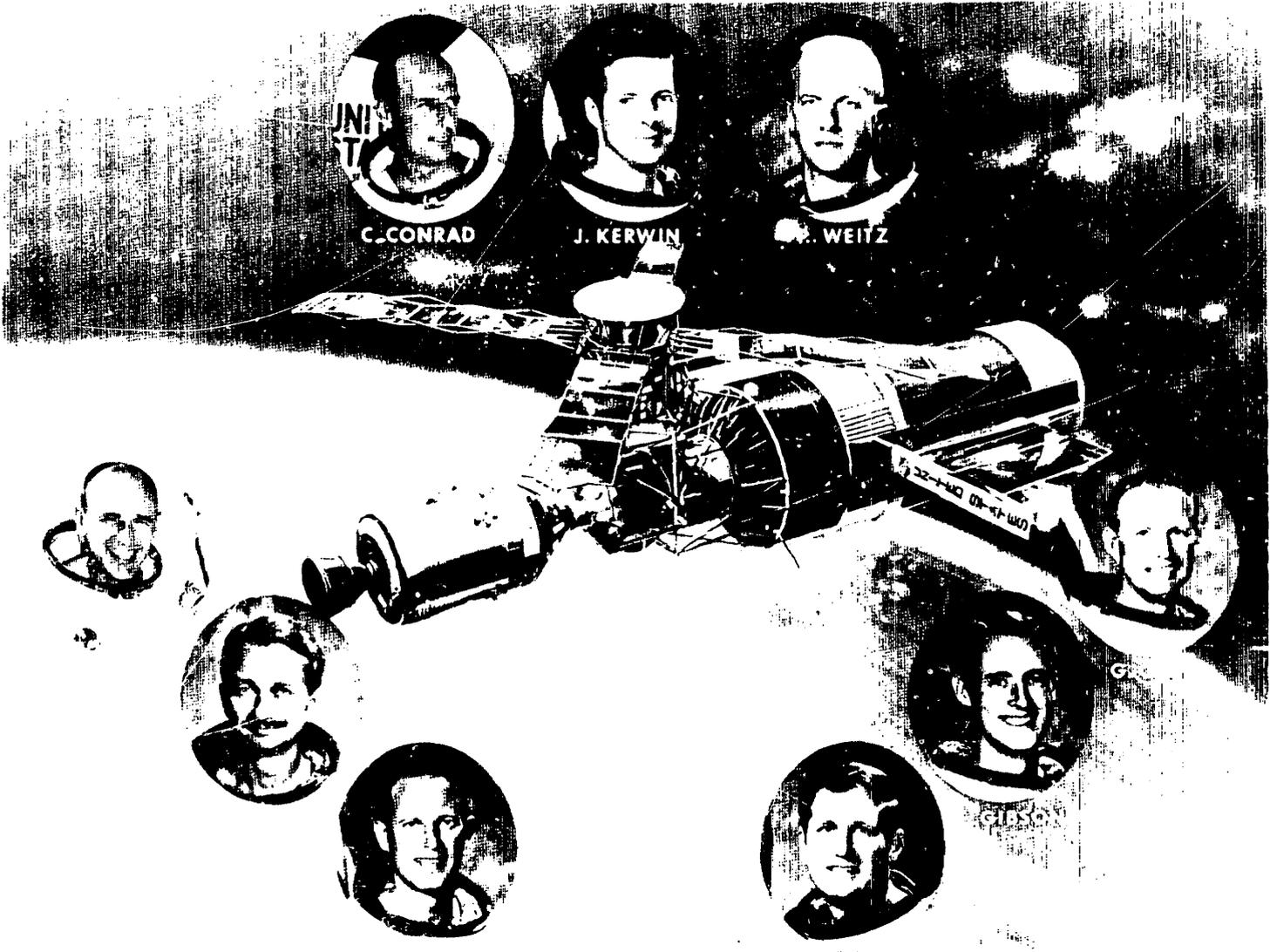
Schedules call for three separate three-man crews to visit Skylab, living and working there for periods up to 56 days. In Skylab's unusual environment, high above earth's atmosphere in the weightlessness and vacuum of space, they then undertake the most intensive space research yet defined. Here they look up to study the sun, look down to observe the earth, and look inward to evaluate man's ability to work successfully in zero-gravity for long periods. No laboratory on earth can provide the answers to questions asked in the Skylab experiments.

At an altitude of 435 kilometers (270 statute miles) Skylab is programmed to speed around the earth in an easterly direction in an orbit at a 50-degree angle from the equator's plane. Its path reaches 5551 kilometers (3450 miles) north and south of the equator, crisscrossing most of the earth's surface except for the Arctic and Antarctic. Moving at 8 kilometers (5 miles) per second, it completes an orbit in 93 minutes. Its sensitive instruments are capable of observing and recording millions of bits of data about earth's land, sea, and air; about the sun; and about the condition of the crew members themselves.

The Skylab flight program begins with liftoff of the unmanned workshop from the Kennedy Space Center on a two-stage Saturn V vehicle. Skylab then maneuvers into its planned attitude, points toward the sun, swings its solar observatory 90 degrees from the vertical launch position to operation position, and pressurizes its quarters with an oxygen-nitrogen environment to make ready for the arrival of the astronauts. One day after the Saturn V launch a Saturn IB boosts an Apollo spacecraft and the first three-man crew into a low earth orbit. Using the spacecraft's service propulsion system, the astronauts climb to the Skylab's altitude, dock, and enter. After 28 days they reenter their spacecraft and return to earth for a splashdown in the Pacific Ocean. About 60 days after the first crew's return, another Saturn IB starts a second crew on a visit to Skylab, this time for 56 days. And 30 days after the second crew's return to a Pacific recovery area, a third crew lifts off for another 56-day flight. Recovery of the third crew is in the Pacific Ocean.

Skylab is the most ambitious project in space to date. The chronology within this book attempts in some small measure to document those major events that led to such a major space feat. This chronology covers NASA-wide events in general and some MSFC events in greater detail.

Appreciation is expressed to personnel of the MSFC Skylab Program Office as well as to the publications personnel of Hayes Corporation who have been unusually helpful in preparation of this Skylab Chronology.



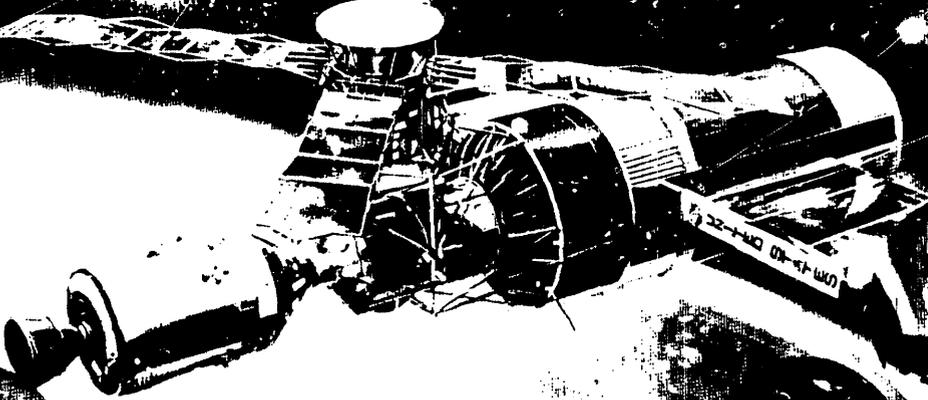
C. CONRAD



J. KERWIN



W. WEITZ



1962 - 1965

## November 1962 – December 1965

### 1962

**NOVEMBER:** The first documented report to suggest use of an S-IVB stage as a laboratory in space was published by Douglas Aircraft Company. Meanwhile, at MSFC similar ideas were generating, though not yet to the extent of being published as a report [1].

### 1965

**MARCH:** MSFC program analysts and developers were beginning to use the terms "spent stage" and "wet workshop" in reference to the possibility of taking fuel from an S-IVB stage in space and then using the stage as a laboratory [2].

**AUGUST 6:** Dr. George E. Mueller, Associate Administrator for Manned Space Flight, NASA Headquarters, announced the establishment at Headquarters of an Apollo Applications Program Office. Being effective with this announcement, the Apollo Applications Program came into existence, replacing the old Apollo Extension Systems Program [3].

**AUGUST 20:** As a part of MSFC's activities relative to the Apollo Extension System Program, a concept was identified which showed potential for a comprehensive accomplishment of experiments associated with the earth orbital phase of the program. This concept, the S-IVB Orbital Workshop, involves an "in-orbit" conversion of a spent S-IVB stage to a shelter suitable for habitation and utilization by man. A four-month conceptual design study was initiated to further define this concept and its potential. Both MSC and Douglas Aircraft were to participate in this study [4].

**AUGUST 25:** A Technical Working Group was established at MSFC for the S-IVB Conceptual design study under the co-chairmanship of J. Laue and W. Thompson (R-P&VE-AB)[5].

**SEPTEMBER 10:** The Apollo Extension System was formally redesignated Apollo Applications [6].

**OCTOBER 20:** MSFC and MSC held their first coordination meeting on the S-IVB Workshop and the related AAP experiment activities. One of the major requests from this meeting was a requirement for the S-IVB/Apollo CSM Workshop concept to handle an artificial gravity experiment. MSFC, with support from DAC and Langley, was going to create these design concepts. Langley had already completed considerable effort on the MORL and their supporting technology programs in this area [7].

**DECEMBER 1:** Dr. George Mueller gave MSFC the go-ahead for the Orbital Workshop. MSFC was directed to present a Program Development Plan at the Management Council Meeting to be held on December 21 and 22. Dr. Mueller desired that the Workshop be flown on SA-209. In addition to the plan, MSFC was also requested to present the work that had been done in execution of the plan. Furthermore, it was decided that the Workshop would be a project of MSFC with Mr. William Ferguson in charge [8].

**DECEMBER 23:** In a memo to the Gemini Project Manager at MSC, MSFC solicited their assistance, as well as that of McDonnell Aircraft, in determining the feasibility of using Gemini subsystems on the Airlock splice experiment. During the course of the December OMSF Management Council Meeting, Dr. Mueller directed that McDonnell Aircraft appraise the applicability of the Gemini hardware for this purpose [9].

1966

1966

**JANUARY 1:** MSFC Director Wernher von Braun named Dr. J.C. McCall to organize and manage the Experiments and Applications Office, which would manage MSFC's portion of the Apollo Applications Program [10].

**FEBRUARY 25:** To summarize prior agreements and discussions, a TWX was sent by NASA Headquarters to MSFC and MSC delineating responsibilities. MSFC was given the overall system design and integration responsibility for the S-IVB Workshop. The design objective was for a 30-day flight capability, with a lower limit of 14 days. MSC Gemini Program Office had contractual and detail design responsibility for the Airlock Module, which would utilize Gemini Components wherever feasible [11].

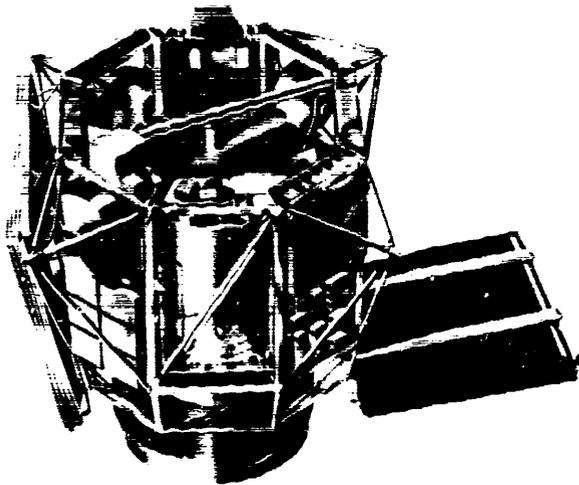
**MARCH 23:** The Apollo Extension Systems had been proposed as a program to utilize Apollo Saturn capabilities and hardware to fly future missions and thereby to minimize the initial development cost of new systems. Subsequently, the name of the project was changed to Apollo Applications. NASA's first "officially released" schedule in the Apollo Applications Program (AAP) was Schedule ML-4, released by NASA on March 23, 1966. This schedule called for 26 Saturn IB launches and 19 Saturn V launches. Involved in the launches would be three S-IVB/Spent Stage Experiment Support Modules (SSESM), three Saturn V Workshops, and four Apollo Telescope Mounts (ATM'S). This schedule also included five lunar missions and two synchronous orbit missions. According to this ML-4 schedule, the first S-IVB/SSESM would be launched in April 1968. Early groundrules established at the time of the ML-4 schedule called for noninterference with the basic Apollo Lunar Landing Program, minimum modification of Apollo hardware, and compatibility with Apollo launch vehicles. Prior to the ML-4 schedule, the program plans

included two phases: (1) Phase I - short-duration (nominal 14 days) orbital missions using unmodified Apollo Block II hardware, and (2) Phase II - extended-duration missions (up to 45 days) using Apollo Block III hardware with new or modified subsystems. According to the ML-4 schedule, activity on Phase I was stopped and activity on Phase II would be directed toward the S-IVB/SSESM, the forerunner of the workshop. The SSESM would be mounted on the forward end of the S-IVB stage and would provide docking and an airlock passageway into the S-IVB hydrogen tank. Planning called for the Command and Service Module (CSM) to be launched with the S-IVB/SSESM on a single Saturn IB vehicle. Most experiments at this time were biomedical, and would be carried and performed in the Command Module (CM). The astronauts would enter the passivated S-IVB spent stage through the SSESM. No crew quarters were to be set up in the S-IVB, and, therefore, basic activity would amount to familiarization with zero-g locomotion in a controlled and enclosed environment [12].



**EARLY SIMPLIFIED ATM CONCEPT USING APOLLO CSM**

May – July 1966



**APOLLO TELESCOPE MOUNT**

**MAY 23:** The Manned Space Flight Experiments Board approved Experiment SO27, Galactic X-Ray Mapping, for assignment to the Apollo Applications Program [13].

**MAY 27:** NASA announced selection of two aerospace companies for negotiation of parallel 1-year study contracts covering integration of experiments and experiments support equipment for manned Apollo Applications. Each contract was estimated at 1 million dollars. The two firms selected were the Lockheed Missiles and Space Company and the Martin Company [14].

**JUNE 6:** Douglas Aircraft Corporation was authorized to cut holes in the LH<sub>2</sub> tank and perform other modifications on the S-IVB (210) Stage in preparation for the S-IVB/Spent Stage in preparation for the S-IVB/Spent Stage Experiment Support Module [15].

**JUNE 27:** The establishment of the Saturn/Apollo Applications Program Office at MSFC under the direction of Mr. Leland F. Belew was officially approved by the NASA Administrator [16].



**EARLY CM/ATM CONCEPT USING APOLLO HARDWARE**

**JULY 3:** The MSFC Saturn/Apollo Applications Program Office formalized the following appointments [17]:

Stanley R. Reinartz, Deputy Manager

Hilmar W. Haenisch, Assistant Manager

Jack C. Swearingen, Manager, Program Control Office

Rein Ise, Manager, Apollo Telescope Mount Project

Jack H. Waite, Manager, Mission Planning and Experiments Project (now Experiment Development and Payload Evaluation Project)

**JULY 18:** Effective this date, Dr. George E. Mueller assigned OMSF management responsibility for development of the S-IVB Workshop and the Spent Stage Experiment Support Module (SSESM) to the Director, Saturn/Apollo Applications [18].

## July – September 1966

**JULY 25:** MSFC presented the Orbital Workshop as an experiment to the MSFEB. The result of this presentation was that it was approved by Dr. Mueller and was to be flown on AS-209 [19].

**JULY 25:** The Manned Space Flight Experiment Board approved the following changes to the list of corollary experiments for the Apollo Applications Program. Experiments added were SO09 (Nuclear Emulsion), M402 (Orbital Workshop), and TO18 (Precision Optical Tracking) [20].

**JULY 26:** OMSF was assigned full responsibility for the conduct of Apollo and Apollo Applications missions. The assignment included funding approved integral experiment hardware, providing the required Apollo and Saturn systems, integrating the various experiments with these systems, and planning and executing the missions. Two OMSF Centers were assigned the following responsibilities: MSFC – the Apollo Telescope Mount; MSC – the Apollo Lunar Surface Experiment Package, lunar science experiments, life support systems, and earth (surface) resources experiments [21].

**AUGUST 14:** The MSFC Saturn/Apollo Applications Program Office announced the appointment of George B. Hardy as Manager, Program Engineering and Integration Project [22].

**AUGUST 19:** NASA selected the McDonnell Aircraft Corporation for negotiations on a fixed-price contract to produce an airlock for an experiment in which astronauts would enter the empty hydrogen tank of a spent Up-rated Saturn I second stage. Estimated cost of the work was 9 million dollars [23].

**SEPTEMBER 6:** Four ATM experiment contracts were transferred to MSFC from GSFC for management since MSFC had been given the ATM assignment. The four experiments were with American Science and

Engineering, Harvard College Observatory, High Altitude Observatory, and the Naval Research Laboratory. These contracts had originated during 1964 and 1965 [24].

**SEPTEMBER 19:** The Manned Space Flight Experiment Board approved the following changes to the list of corollary experiments for the Apollo Applications Program [25]. Experiments added were as follows:

- M469 ST-124 Removal and Disassembly
- M492 Tube Joining in Space
- M493 Electron Beam Welding
- M466 Suits and Lunar Hardware
- M479 Zero Gravity Flammability
- M484 Orbital Workshop Artificial "G"
- M486 Astronaut EVA Equipment
- M487 Habitability/Crew Quarters
- M488 High Pressure Gas Expulsion
- M489 Heat Exchanger Service
- M050 Metabolic Activities
- M051 Cardiovascular Function Assessment
- M052 Bone and Muscle Changes
- D018 Integrated Maintenance
- D019 Suit Donning and Sleep Evaluation
- D020 Alternate Restraints Evaluation
- D021 Expandable Airlock Technology

## September – December 1966

### D022 Expandable Structures for Recovery

**OCTOBER 3:** John A. Chambers was assigned as Manager, Test, Reliability, Quality Assurance, and Safety Office in the MSFC Saturn/Apollo Applications Program Office [26].

**OCTOBER 31:** Configuration and mission studies were conducted during the months of September and October toward fulfilling the following goals: an operating set of modules suitable for reuse and resupply in 1969; at least one 3-man, 28-day mission; at least one 3-man, 56-day mission; and the maximum amount of solar observations possible [27].

**NOVEMBER 21:** The Manned Space Flight Experiment Board approved the following changes to the list of corollary experiments for the Apollo Applications Program [28]. Experiments added were as follows:

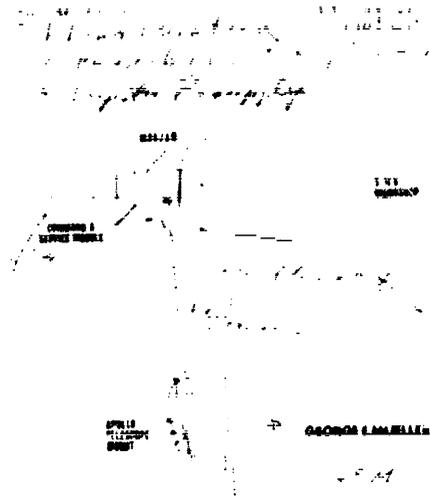
- M053 Human Vestibular Function
- M055 Time & Motion Study
- T017 Meteoroid Impact & Erosion
- T020 Jet Shoes
- T021 Meteoroid Velocity
- T022 Heat Pipe
- S017 X-Ray Astronomy
- S019 UV Stellar Astronomy
- S020 UV/X-Ray Solar Photography
- S063 UV Airglow Horizon Photography
- S065 Multiband Terrain Photography

**NOVEMBER 30:** Charles W. Mathews, MSC Gemini Program Manager, was named Director of Saturn-Apollo Applications in the NASA Headquarters Office of Manned Space Flight [29].

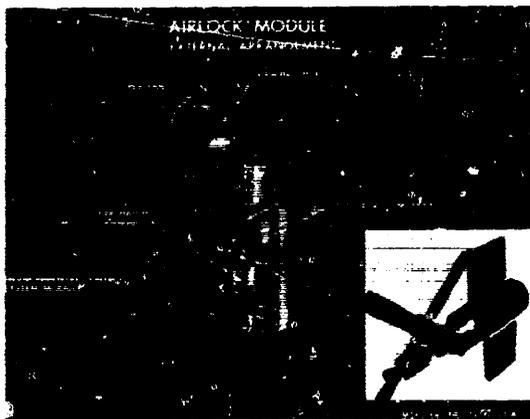
**DECEMBER 5:** With Schedule ML-5B, issued by NASA, the cluster concept entered the AAP design following studies completed a short time earlier. The ML-5B schedule called for 22 Saturn IB and 15 Saturn V launches. Included in the launch of the 22 Saturn IB's would be two Saturn IB's launched approximately a day apart, one Saturn IB manned and the other one unmanned. Among the Saturn flights scheduled in ML-5B would be flights utilizing two Saturn V Workshops and four LM/ATM missions. Lunar missions were also included in this schedule. The ML-5B cluster concept was considered to consist of a workshop to be launched following a manned vehicle launch, and, 6 months later, a LM/ATM launch following another manned mission. The LM/ATM would rendezvous and dock to the cluster. According to the ML-5B schedule, the first workshop launch would be in June 1968. The S-IVB/SSESMS had been a comparatively simple mission, requiring no rendezvous and docking and no habitation equipment, but the ML-5B schedule reflected the sophisticated habitable Orbital Workshop and cluster concept, a much more complex program. The one major similarity between the old S-IVB/SSESMS concept and the cluster concept was that both utilized the propulsive S-IVB stage to put the payload into orbit prior to passivation and pressurization of the hydrogen tank in orbit. But, this new concept provided for the major step of making the Saturn-IVB habitable by passivating and pressurizing the hydrogen tank in orbit for a workshop environment that later would be called the "wet" workshop. A two-gas atmosphere of oxygen and nitrogen replaced the S-IVB/SSESMS one-gas oxygen system, and a shirt-sleeve environment was incorporated. The

December 1966

first Orbital Workshop (OWS) envisioned would consist of crew quarters in the S-IVB hydrogen tank (two floors and walls installed on the ground) to be modified by the stage contractor, Douglas Aircraft, and managed by MSFC; an airlock module (AM), previously called a Spent Stage Experiment Support Module, attached to the OWS, to be built by McDonnell Aircraft and managed by MSC; and a multiple docking adapter (MDA) to be developed containing five docking ports which would permit up to five modules to be docked to the workshop at any one time. The MDA would also be utilized for storage of most OWS astronaut habitability equipment and experiments from launch to orbit [30].



EARLY CLUSTER CONCEPT  
WITH TETHERED ATM  
SKETCHED BY DR. GEORGE MUELLER  
AUGUST 19, 1966, DURING  
MEETING AT MSFC



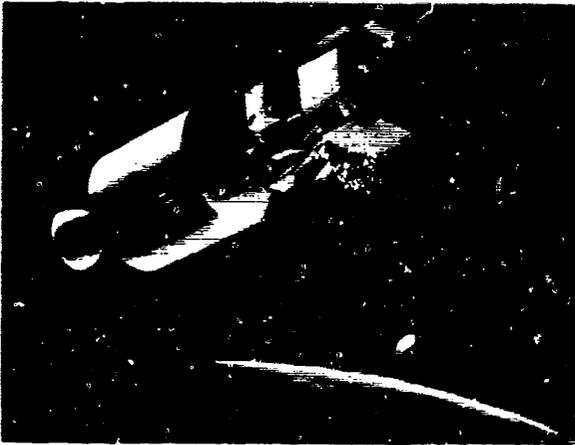
AIRLOCK MODULE

DECEMBER 16: A contract with Bendix Corporation was awarded by MSFC for development of a Control Moment Gyro to control the attitude of the ATM in orbit [31].

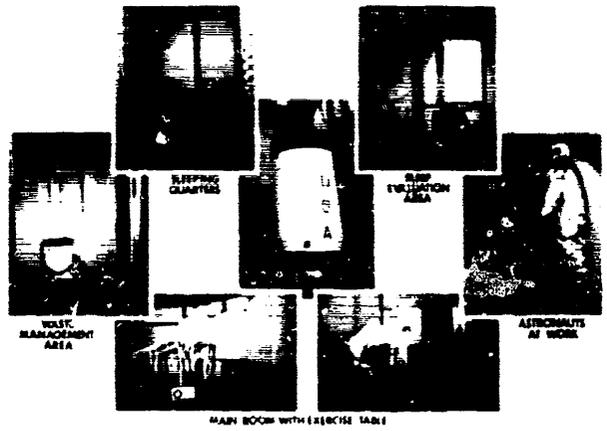


MULTIPLE DOCKING ADAPTER

December 1966



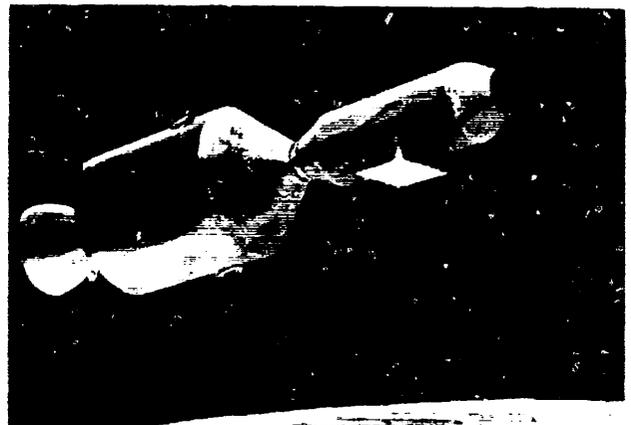
COMMAND AND SERVICE MODULE,  
TRANSFERRING LUNAR  
MODULE/APOLLO TELESCOPE  
MOUNT TO CLUSTER



S-IVB ORBITAL WORKSHOP



WET WORKSHOP CLUSTER WITH ATM,  
CSM, AND LUNAR MAPPING AND  
SURVEY SYSTEM MODULE DOCKED



QUALIFICATION OF LM&SS IN  
EARTH ORBIT

1967

## January – March 1967

1967

**JANUARY 26:** George E. Mueller, in a briefing at NASA Headquarters, said that plans were to form an "embryonic space station" in 1968-1969 by clustering four AA payloads launched with Uprated Saturn I boosters. The first mission would be the launch of a manned spacecraft, followed several days later by launch of a spend S-IVB stage converted into a workshop. After the two spacecraft had docked, the crew would enter the workshop through an airlock. They would prepare the workshop for storage and return to earth in their spacecraft 28 days later. In three to six months, a second manned capsule would be launched on a 56-day mission to deliver a resupply module to the workshop and rendezvous with an unmanned ATM, the fourth and last launch of the series. The cluster would be joined with multiple docking launched on S-IVB workshop. Emphasizing the importance of manning the ATM, Dr. Mueller said: "...if there is one thing the scientific community is agreed on it is that when you want to have a major telescope instrument in space it needs to be manned..." [32].

**FEBRUARY 6:** The Manned Space Flight Experiment Board approved the following changes to the list of corollary experiments for the Apollo Applications Program. The two experiments added were MO18 (Vectorcardiogram) and M423 (Hydrostatic Gas Bearing) [33].

**MARCH 2:** NASA announced MSFC would design and build in-house a multiple docking adapter (MDA) for use in an AA payload cluster scheduled for launch in 1968-69. Preliminary designs called for a 10-foot-diameter, 15-foot-long cylinder surrounded by five 36-inch-diameter tunnels with docking collars and sealing hatches for orbital docking [34].

**MARCH 12:** NASA agreed to fly four DoD experiments on Apollo Applications missions to support the Air Force's Manned Orbiting Laboratory. Experiments selected were: study of an inflatable elastic airlock; use of alternate restraints to determine standard workshop technique in weightlessness; evaluation of suit donning and sleep stations; and integration of multipurpose equipment maintenance [35].

**MARCH 15:** The Naval Research Laboratory awarded a subcontract to Bali Brothers Corporation for the production of the ATM NRL experiments. Prior subcontract had been let with Ball for production of the High Altitude Observatory experiment on January 11, 1965, and for Harvard College Observatory Experiment on December 27, 1966 [36].

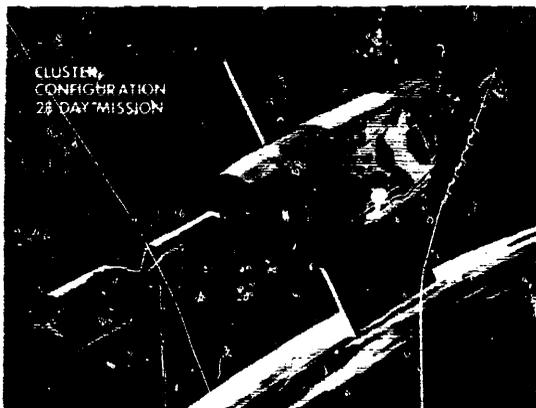
**MARCH 20:** MSFC awarded Bendix Corporation a 7.4-million-dollar, cost-plus-award-fee contract for development and production of ATM pointing control system (PCS). Bendix would produce three units by August. The ATM system would permit Apollo astronauts to point a telescope to selected regions of the sun during a period of maximum solar flare activities beginning in late 1968. American Optical Company, under a 740,460-dollar contract, would build a dynamic simulator for use in developing the PCS [37].

**MARCH 20:** The Manned Space Flight Experiment Board approved the following changes to the list of corollary experiments for the Apollo Applications Program. Experiment SO16 (Trapped Particles Asymmetry) was added to the program [38].

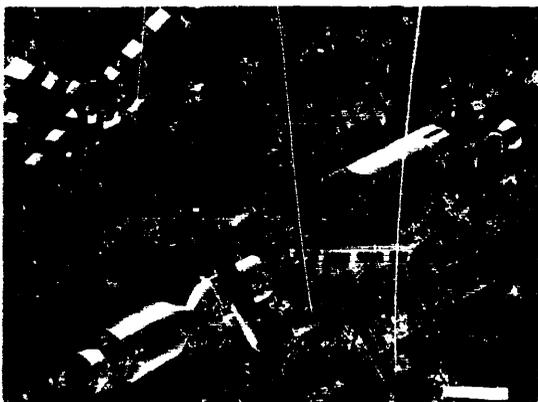
**MARCH 24:** NASA decided to add two solar array wings to its Apollo Applications Program Orbital Workshop. The solar array wings on the OWS would be 180 deg apart and run the length of the OWS. This addition was deemed necessary because of the increased electrical

## March – July 1967

power requirements resulting from habitation of the workshop. Until this change in requirement, the CSM had been considered the primary power source for the cluster except for the Apollo Telescope Mount which would still have its own solar arrays and power system [39].



**CLUSTER WITH SOLAR ARRAY WINGS  
ADDED TO WORKSHOP**



**EARLY 1967 STUDY CONFIGURATION OF  
TETHERED LM/ATM**

**APRIL 28:** Douglas Aircraft Corporation merged with McDonnell Aircraft Corporation and became known as McDonnell Douglas Corporation [40].

**MAY 24:** NASA realigned its Apollo and AAP launch schedules as a result of the accident in early 1967. This new AAP schedule ML-6 called for 25 Saturn IB and 14 Saturn V launches. Major hardware involved in these launches would be two workshops flown on Saturn IB vehicles, two Saturn V Workshops, and three ATM's. Also planned were nine lunar missions and one MARS mission called Voyager. According to this new May 24, 1967, schedule the first launch of a workshop would be in January of 1969 [41].

**JUNE 26:** The Manned Space Flight Experiment Board approved the following changes to the list of corollary experiments for the Apollo Applications Program. T023 (Surface Adsorbed Materials) and M508 (EVA Hardware Evaluation) were added and M466 (Suits and Lunar Hardware) and M486 (Astronaut EVA Equipment) were deleted [42].

**JULY 17:** The Manned Space Flight Experiment Board approved the following changes to the list of corollary experiments for the Apollo Applications Program [43]. The following experiments were added:

- T013 Crew/Vehicle Disturbance
- M056 Non-Gravimetric Mass Measurement
- M058 Human Mass Measurement Device
- T003 In-Flight Nephelometer
- M509 Astronaut Maneuvering Equipment

S005 Synoptic Terrain Photography

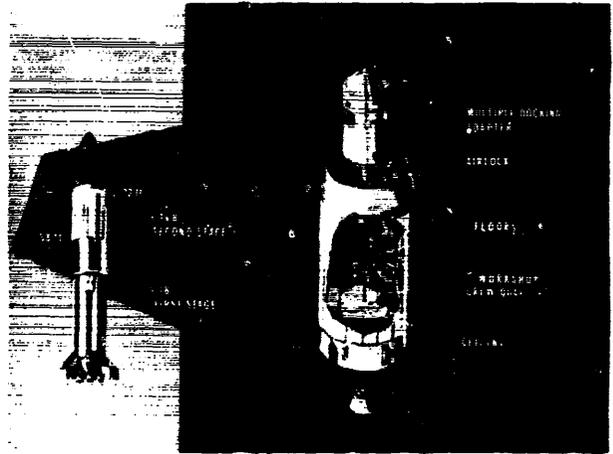
S006 Synoptic Weather Photography

S028 Dim Light Photography

**JULY 26:** NASA awarded The Boeing Company a \$2.275-million, cost-plus-fixed-fee contract for procurement of long-lead-time materials for two additional Saturn V launch vehicles. The contract, which would expire January 1, 1968, was the first Saturn V procurement in support of AA program [44].

**JULY 26:** NASA selected Martin Marietta Corporation to negotiate a 27-month, \$25-million, cost-plus-incentive-award fee contract for payload integration of experiments and experiment support equipment on AA spacecraft. Tasks would be performed at NASA's three manned spaceflight centers: (1) MSFC work would involve the Orbital Workshop and Apollo Telescope Mount (ATM); (2) MSC work, the meteorological and earth resources payloads; and (3) KSC work, the test integration planning and support for launch operations. Selection of contractor followed competitive definition phase in which Martin Marietta Corporation and Lockheed Missiles & Space Company studied AA payload integration under parallel, \$2-million, fixed-price contracts [45].

**JULY 28:** NASA decided to incorporate the Workshop's two floors into one common grated floor in the OWS crew quarters to save weight. This concept required the crew quarters to be on one side of the floor and a large open area on the opposite side of the floor, permitting experiment Inter-Vehicular Activity (IVA) in the hydrogen tank dome [46].



**INTERIOR OF ORBITAL WORKSHOP  
SHOWING COMMON FLOOR**

**SEPTEMBER 1:** MSFC returned a McDonnell Douglas-built S-IVB orbital workshop mockup to the contractor's Space Systems Center in Huntington Beach, California, for incorporation of a number of design changes. Following modification, the mockup would represent the S-IVB stage as a manned space laboratory designed for use in the AAP. The design changes included relocation of a floor separating two sections of the stage's LH<sub>2</sub> tank, addition of a ceiling and other fixtures, and relocation of some of the experiment stations [47].

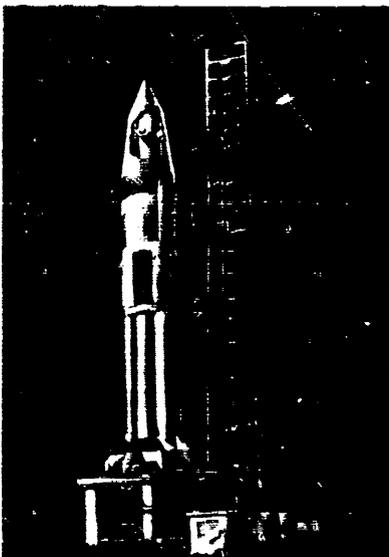
**SEPTEMBER 18:** The Manned Space Flight Experiment Board approved the following changes to the list of corollary experiments for the Apollo Applications Program. Experiments S051 (Daytime Sodium Cloud) and M415 (Thermal Control Coatings) were added and Experiments M484 (Orbital Workshop Artificial "G"), M488 (High Pressure Gas

## September – November 1967

Expulsion), and D018 (Integrated Maintenance) were deleted [48].

**SEPTEMBER:** Jeffery T. Hamilton was assigned as the Acting MSFC Representative at Manned Spacecraft Center as announced by Dr. Wernher von Braun, Director, MSFC, in a letter to Dr. Robert R. Gilruth, Director, MSC. In addition to his duties of MSFC Representative, Hamilton also served as Saturn/Apollo Applications Representative [49].

**OCTOBER 3:** NASA published its AAP schedule ML-7, a schedule that reflected current budgetary restraints. This schedule reflected the reduced AAP lunar activity to four missions and Saturn V Workshop activity calling for only 17 Saturn IB and seven Saturn V launches. During this program of 24 Saturn launches, there would be two Workshops launched on Saturn IB vehicles, one Saturn V Workshop, and three ATM's. Launch of the first Workshop was scheduled for March 1970 [50].



**AAP NO. 2 LAUNCH CONFIGURATION  
(CUTAWAY SHOWING MDA)**

**OCTOBER 26:** An active cooling system (fluid circulation) was incorporated into the ATM thermal system to meet temperature control requirements [51].

**NOVEMBER 9:** NASA achieved a critical point in the Apollo Program with the Apollo 4 flight (AS-501), an "all-up" launch from LC-39 at KSC at 7:00 a.m., EST. The flight, termed "perfect," demonstrated that the spacecraft, heat shield, and lunar rocket met program requirements [52]:

**NOVEMBER 13:** A NASA Resident Management Office was established at Martin Marietta Corporation, Denver Division, to aid in the management of the payload integration contract (NAS8-21004) and Apollo Applications Program (AAP). W.E. Davidson was appointed the joint MSFC/MSC Resident Manager, reporting organizationally to L.F. Belew, MSFC [53].

**NOVEMBER 20:** The Manned Space Flight Experiment Board approved the following changes to the list of corollary experiments for the Apollo Applications Program [54]. Experiment T022 (Heat Pipe) was deleted and the following experiments were added:

- T025 Coronagraph Contamination Measurements
- T027 ATM Contamination Measurements
- S073 Gegenschein/Zodiacal Light
- S039 Day-Night Camera System
- S043 IR Temperature Sounding
- S049 IR Interferometer Spectrometer
- S050 IR Temperature Profile Radiometer
- S075 Elec-Scan Microwave Radiometer

November 1967

- S100 Metric Camera
- S101 Multiband Photography
- S102 Dual-Channel Scanner-Imager
- S103 Short Wavelength Spectrometer
- S104 Microwave Temperature Sounder
- D017 Solid Electrolyte Carbon Dioxide Reduction

and behavioral considerations and systems development; scientific investigations in earth orbit based on solar astronomy, earth observations, and stellar astronomy; applications in earth orbit based on meteorology, earth resources, and communications; and extended lunar exploration. "The activities involved in [AAP] represent major steps in the utilization of our space exploration and applications. In particular, increased knowledge on the effective integration of men into the total system should accomplish much in determining the character, systems configurations, and operational approach in future programs. The ability to capitalize on the large investments already made in the Apollo Program affords the opportunity to carry on this work in [AAP] in an efficient and economical manner" [55].

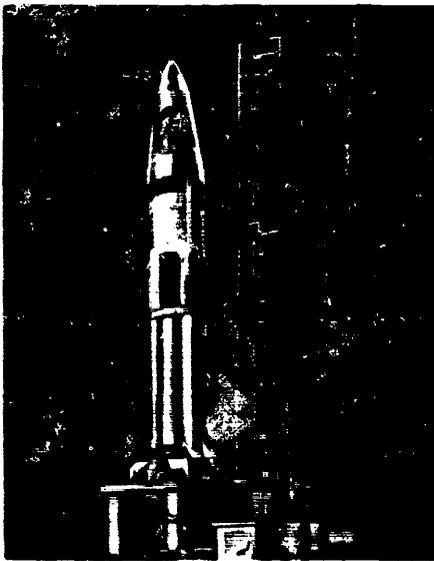
**NOVEMBER 27:** NASA's Apollo Applications Program Director, Charles W. Mathews, listed basic objectives for AAP: Long-duration space flights of men and systems based on unique capabilities of man, habitability, biomedical

**1968**

1968

**JANUARY 9:** A contract was awarded by MSFC to Perkin Elmer for the ATM H-Alpha telescopes [56].

**JANUARY 9:** NASA budgetary restraints required an additional cut in AAP launches, as reflected in the AAP "Launch Readiness and Delivery Schedule ML-13A" released by NASA. The reduced program called for 12 Saturn IB and 3 Saturn V launches, including one Workshop launched on a Saturn IB vehicle, and the program also called for one Saturn V Workshop and one ATM. Two lunar missions were planned. Launch of the first Workshop would be in April 1970. This schedule provided for a 15-month break in Saturn V production with zero funding in FY 1969 [57].



**AAP NO. 4 LAUNCH CONFIGURATION**

**JANUARY 16:** NASA awarded a letter contract to Martin Marietta for the payload integration effort on the Apollo Applications Program [58].

**JANUARY 25:** The Post Apollo Advisory Committee, authorized by the NASA Administrator to evaluate and make recommendations on post-Apollo space activities, held a meeting at MSFC. The committee, headed by Dr. Floyd Thompson, Special Assistant to the Administrator, held three additional meetings – February 15, 1968, at MSC; March 12, 1968, at Headquarters; and March 25 & 26, 1968, at KSC. The report (dated July 20, 1968) by this committee confirmed the basic objectives of the Apollo Applications Program and played a deciding role in its later evolution [59].

**JANUARY:** William C. Houston was assigned as MSFC Program Representative, Saturn/Apollo Applications Program Office, with duty station at KSC [60].

**FEBRUARY 15:** Twenty NASA astronauts visited MSFC for an orientation tour and briefing concerning the Apollo Applications Program (AAP), especially the Orbital Workshop [61].

**MARCH 18:** The Manned Space Flight Experiment Board approved the following changes to the list of corollary experiments for the Apollo Applications Program. Experiment M113 (Blood Volume/Red Cell Life Span) was added and Experiments S016 (Trapped Particles Asymmetry), S069 (X-Ray Astronomy, which was formerly S017, and M469 (St-124 Removal and Disassembly) were deleted [62].

**APRIL 16:** Charles W. Mathews, Director of NASA Apollo Applications Program, told the National Space Club in Washington, D.C., that NASA's manned space plan, beyond first Apollo landing, "...contemplates a balanced activity of lunar exploration and extension of man's capabilities in earth orbit." The Program had been designed for flexibility so activities could be conducted in harmony with available resources. "We are also prepared to move forward at an increased pace when it is

## April – June 1968

desirable and possible to do so.” Both civil benefits and national security implications of space program warranted continued strong support. Contingency planning would leave more room for budgetary or goal changes, thus placating critics in Congress who claimed NASA had not provided them with sufficient flexibility [65].

**MAY 1:** Mr. Harold T. Luskin was appointed Director, Apollo Applications, in the Office of Manned Space Flight. Mr. Luskin came to NASA in March of 1968 as Deputy Associate Administrator for Manned Space Flight, Technical [64].

**MAY 9:** The agreement to use the Saturn Automatic Checkout Equipment (ACE) at KSC for pre-launch checkout of the ATM was included in a letter from Dr. Wernher von Braun to Dr. Kurt Debus [65].

**MAY 20:** NASA increased the capability of the Skylab Multiple Docking Adapter (MDA) to provide for crew habitation and to perform certain biomedical experiments in the event the Orbital Workshop could not be made habitable upon reaching orbit [66].

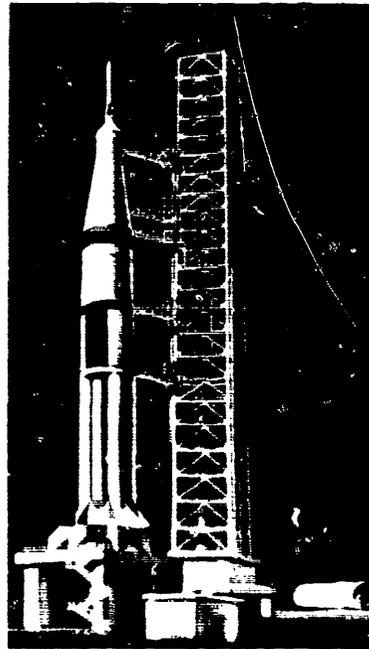
**MAY 23:** AAP directive No. 5 defined the requirements and responsibilities to initiate the actions required for the execution of the AAP-3/AAP-4 mission. The purposes of the mission were to: increase man's knowledge of the sun's characteristics through solar astronomy conducted in space; evaluate the performance characteristics of a manned solar astronomy system in order to develop advanced solar and stellar observation systems; demonstrate feasibility of reactivating a workshop left unattended in earth orbit for several months and reusing it as a base of operations for conducting various experiments [67].

**MAY:** Floyd M. Drummond was assigned as Manager and Wayne Patterson assigned as Chief, Engineering Branch, Airlock

Module/MDA Project, Saturn/Apollo Applications Program Office, MSFC [68].

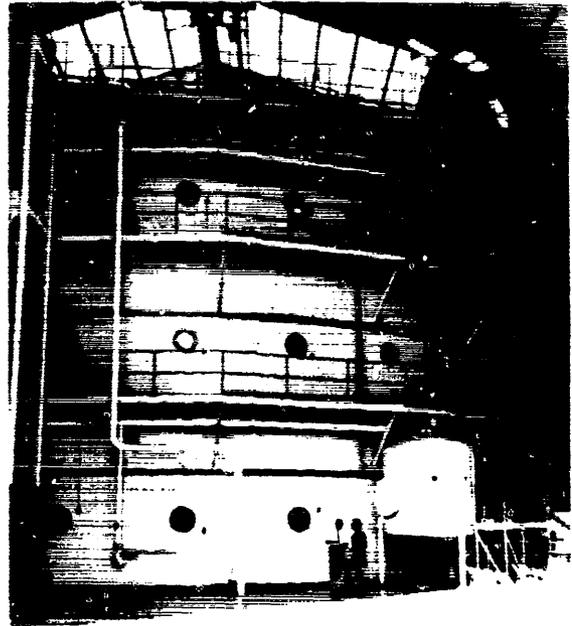
Harold H. Stevenson was assigned as Resident Manager of the Airlock Module Resident Management Office, St. Louis, Missouri. The Resident Management Office was an extension of the MSFC to provide on-site technical direction to the contractor involved in the Saturn/Apollo Applications Program MSFC contracts [69].

**JUNE 4:** NASA released it's AAP, "Launch Readiness and Delivery Schedule ML-14A." This new schedule decreased the number of Saturn flights to 11 Saturn IB flights and one Saturn V flight. It called for three Workshops. One of the Workshops would be launched by a Saturn IB and another would serve as a backup. The third Workshop would be launched by a Saturn V, Schedule ML-14A also included one ATM. Launch of the first Workshop would be in November 1970. Lunar missions were no longer planned in the AAP [70].



**AAP MANNED LAUNCH CONFIGURATION**

**JUNE 8:** NASA successfully launched two Aerobee 150 sounding rockets from WSMR. The first rocket carried Nava' Research Laboratory and University of Maryland payload to a 179-kilometer (111.3-mile) altitude to flight-test flight design verification unit (FDVU) of high resolution spectroheliograph planned for use on Apollo Telescope Mount-A. Second rocket carried American Science and Engineering, Inc., payload to 151-kilometer (93.7-mile) altitude to obtain high resolution X-ray pictures of active region of sun during solar flare and general X-ray emission of solar corona. Rocket and instrumentation performed satisfactorily, but payload of first rocket failed to separate, preventing functioning of parachute recovery system [71].



**MSFC NEUTRAL BUOYANCY FACILITY**

**JUNE 24:** Planning began on an integrated thermal control system to connect the Airlock Module, MDA, and OWS thermal control systems [72].

**AUGUST 30:** Following receipt of NASA direction to limit Saturn V production to vehicle 515, MSFC completed studies and began terminating production of engine hardware for the Apollo and AAP programs. The termination action involved 27 H-1 engines, eight F-1 engines, and three J-2 engines [73].

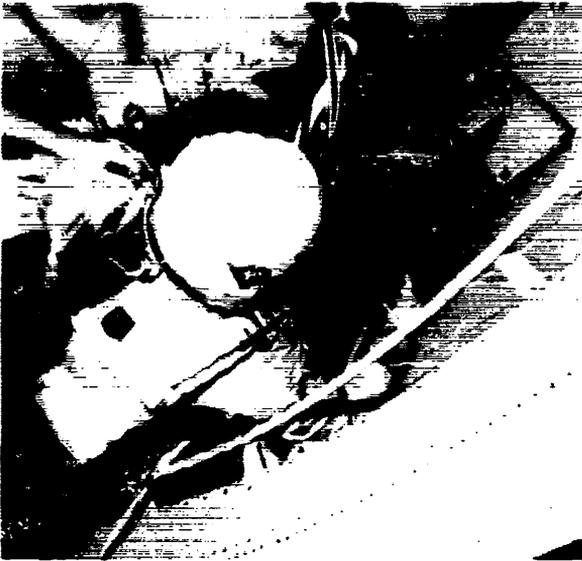


**DR. VON BRAUN SUITING UP FOR FULL PRESSURE SUIT TEST IN MSFC NEUTRAL BUOYANCY SIMULATOR**

**AUGUST:** Robert D. Groeneveld was assigned as MSFC ATM Project Representative, Ball Brothers Corporation, Boulder, Colorado [74].

**SEPTEMBER 4:** Dr. von Braun performed a full-pressure suit test in the Saturn I Workshop mockup emersed in the Neutral Buoyancy Tank. He reported that the upgraded seals used in the aft dome penetration sealing study were "very good." Dr. von Braun recommended additional handholds and tether points [75].

## September – December 1968



**DR. VON BRAUN REMOVING ANTIVORTEX  
SCREEN IN AFT DOME AREA OF  
WORKSHOP NEUTRAL BUOYANCY  
SIMULATOR**

**SEPTEMBER 16:** The Manned Space Flight Experiment Board approved the following changes to the list of corollary experiments for the Apollo Applications Program. Experiment M507 (Gravity Substitute Workbench) was added and Experiment D017 (Solid Electrolyte Carbon Dioxide Reduction) was deleted [76].

**SEPTEMBER 18:** NASA assigned the management responsibility to MSFC for the Airlock Module and the modified Lunar Module Ascent Stage. MSC formerly managed these AAP activities. NASA officials explained that this reassignment was made for the purpose of establishing a satisfactory balance between Apollo and AAP and to place a design integration under a single NASA center [77].

**OCTOBER 9:** NASA released its AAP, "Launch Readiness and Delivery Schedule ML-15," which slipped the first launch of a Workshop into August 1971. This new schedule called for eight Saturn IB's but no Saturn V launches. According to this schedule, there would be one Workshop launched on a Saturn IB, one backup Workshop; no Saturn V Workshop scheduled; and one ATM with a backup [78].

**OCTOBER:** A pioneering concept in the substitution of the "dry" for the "wet" Workshop program was the B-Zero project being studied at MSFC. B-Zero (meaning least sophisticated) was proposed as a standby S-IVB stage stripped of existing hardware and on substitute standby as needed for a "wet" S-IVB stage [79].

**NOVEMBER 4:** The Manned Space Flight Experiment Board approved the following changes to the list of corollary experiments for the Apollo Applications Program. Experiment S028 (Dim Light Photography) was deleted [80].

**DECEMBER 16:** MSFC received a letter of authority from MSC (Dr. R. Gilruth) to proceed with the development and fabrication of certain AAP biomedical experiments for MSC [81].

**DECEMBER 18:** NASA announced the appointment of William C. Schneider, Apollo Mission Director, as Director of the Apollo Applications Program. He succeeded Harold T. Lusk, who died November 25, 1968 [82].

**DECEMBER:** At MSFC Porter Dunlap and Marvis Sanders were assigned as Manager and Deputy Manager, respectively, Ground Support Equipment Project, Saturn/Apollo Applications Program Office [83].

1969

## January – March 1969

1969

**JANUARY 6:** The Manned Space Flight Experiment Board approved the following changes to the list of corollary experiments for the Apollo Applications Program. Two Experiments were added: M132 (Neurological Experiment-EEG) and M512 (Materials Processing in Space), which was a consolidation of M492 (Tube Joining in Space) and M493 (Electron Beam Welding). Experiments S065 (Multiband Terrain Photography) and M489 (Heat Exchanger Service) were deleted [84].

**JANUARY 15:** The underwater test program that was begun at MSFC's Neutral Buoyancy Simulator several years earlier was providing information essential for design of first U.S. space station, NASA reported. Technicians, design engineers, and professional divers in spacesuits and scuba gear were conducting tasks similar to those necessary to activate space orbiting workshop. The tasks were performed in a 1.4-million-gal water tank containing mockups of AAP cluster elements (Saturn I Workshop, lunar module ascent stage, Apollo Telescope Mount solar observatory, and Airlock and Multiple Docking Adapter), simulating weightlessness of space. Weightlessness was impossible to duplicate on earth for longer than a fraction of a minute. Conclusions from tests would be reflected in the Workshop's final design, with decision expected in May 1969 [85].

**JANUARY 20:** Dr. von Braun invited Dr. Gilruth of MSC to send MSC representatives to attend a long-life hardware symposium at MSFC on March 17-19, 1969. Dr. von Braun stated that he "would like to encourage strong participation from personnel at MSC who are concerned with long-duration missions such as the AAP-2/4 and future Space Stations. Such a meeting should benefit both our centers" [86].

**JANUARY 30:** A letter contract between MSFC and Martin Marietta Company was definitized for the Payload Integration and

Systems Engineering effort and the ATM controls and display console on the Apollo Applications Program. The estimated cost-plus-fixed-fee contract was 98,200,000 dollars [87].

**JANUARY:** At MSFC William K. Simmons, Jr., and Elmer L. Field were assigned as Manager and Deputy Manager, respectively, Orbital Workshop Project (now Saturn Workshop Project), Saturn/Apollo Applications Program Office [88].

**FEBRUARY 12:** An Aerobee 150 sounding rocket launched by NASA from WSMR carried Nava! Research Laboratory payload to a 187.9-kilometer (116.8-mile) altitude to record photographically 18 EUV spectra of solar photosphere, chromosphere and corona, using SPARCS and flight-design verification unit of high-resolution spectrograph planned for ATM-A and ATM-B. Rocket and instruments performed satisfactorily [89].

**MARCH 4:** A few days before Apollo 9 astronauts McDivitt, Schweikart, and Scott prepared to splashdown in the Pacific, other astronauts were splashing down at MSFC. Three astronauts from the Manned Spacecraft Center, who were involved in Apollo Applications Space Exploration, worked inside the Neutral Buoyancy Simulator at MSFC. The three were Dr. Edward G. Gibson, Lt. Commander Joseph Kerwin (a medical doctor), Lt. Commander Paul J. Weitz. Inside the large water tank the astronauts were able to maneuver inside and around a full-scale replica of an Apollo Telescope Mount and Saturn I Workshop. The MSFC swims occurred during the week of March 5 [90].

**MARCH 7:** The Manned Space Flight Experiment Board approved the following changes to the list of corollary experiments for the Apollo Applications Program. Experiment D024 (Thermal Control Coatings) was added and Experiment T023 (Surface Adsorbed Materials) was deleted [91].

## March – May 1969

**MARCH 27:** MSFC announced a \$7,384,543 modification to its contract with Chrysler Corporation Space Division for assembly of two boosters for Saturn IB rockets 213 and 214 for use in Apollo Applications Program [92].

**APRIL 8:** NASA released its AAP, "Launch Readiness and Delivery Schedule ML-16." This new schedule called for the same number of Saturn IB and Saturn V launches as ML-15, but moved the launch of the first Workshop 3 months to November 1971 [93].

**APRIL 18:** MSFC announced that it had issued RFP's for assistance in producing 320 completed solar "arrays" to convert solar energy into electrical power to operate the Saturn I Works' op. A preproposal conference was scheduled at MSFC on May 1 [94].



**ATM SOLAR ARRAY DEVELOPMENT WING DEPLOYED**

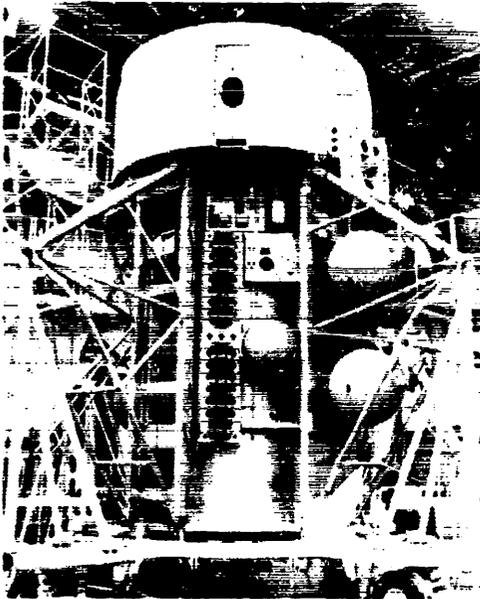


**WORKSHOP SOLAR ARRAY WING BEING DEPLOYED**

**APRIL 29:** In a subject area related to orbiting space laboratories some 250 scientists and engineers from universities, government, and industry attended a workshop on optical telescope technology at MSFC April 29 through May 1, 1969. The purpose of the workshop was the exchange of technical information related to the design of future space telescopes and identification of the research and technology efforts needed to support future missions. NASA's Office of Advanced Research and Technology (OART) and its Office of Space Science and Applications (OSSA) sponsored the Workshop. Speakers discussed the use of space telescopes and the instrumentation necessary for selecting astronomy tasks [95].

**MAY 2:** NASA unloaded an eight-ton airlock at MSFC for ground testing to qualify it as part

of an orbiting space station. The airlock was part of the Apollo Applications Program cluster to be launched in the mid-1970's. NASA flew the 65-inch-diameter, 17-foot cylindrical unit from McDonnell Douglas Corporation's St. Louis plant to be joined to the Multiple Docking Adapter. It would provide an interconnecting passageway between the S-IVB rocket stage and the Multiple Docking Adapter in flight, condition environmental gases, and provide instrumentation, data management, intercommunication, and other services [96].



**AIRLOCK TEST ARTICLE ON PRODUCTION LINE**

**MAY 5:** The Manned Space Flight Experiment Board approved the following changes to the list of corollary experiments for the Apollo Applications Program. Experiment S149 (Particle Collection) was added and Experiment S027 (ATM Contamination Measurements) was changed to S150 [97].

**MAY 16:** MSFC awarded a 4,620,310-dollar contract modification to Chrysler

Corporation's Space Division for vehicle systems engineering and integration on Saturn IB vehicles scheduled for NASA Apollo Applications Program flights. Work begun on January 1, 1969, would extend through March 31, 1970 [98].

**MAY 18:** Responding to a question on NBC's TV program "Meet the Press," NASA Administrator Dr. Thomas O. Paine said that use of the Manned Orbital Laboratory (MOL) and of NASA's orbital workshop were "two very different projects." NASA's was a "longer range program aimed at a very substantial facility which would be really a university campus type research station in orbit." MOL was a "program that is well advanced, and is designed to find out the military applications of space [99]."

**JUNE 10:** The Department of Defense announced that it had canceled the Manned Orbiting Laboratory (MOL) program initiated in 1965 to advance the development of both manned and unmanned defense-oriented space equipment and to ascertain the full extent of man's utility in space for defense purposes. Following this action certain items in the MOL program were placed on a stop-work status for 2 weeks to enable NASA to examine them for possible interest. The items included a food and diet development project, a suit development and technology project, an environmental control and life support system, a water purification system, and a waste management system [100].

**JUNE 23:** Following termination of the Air Force MOL program, NASA requested the transfer of the following MOL projects to NASA: the food and diet development contract with Whirlpool and the space suit development contract with Hamilton-Standard [101].

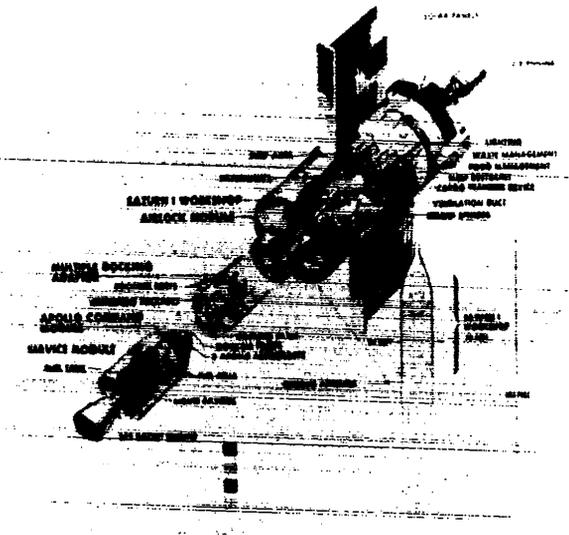
**JULY 7:** The Manned Space Flight Experiment Board approved the following changes to the list of corollary experiments for

## July 1969

the Apollo Applications Program. Experiments M112 (Man's Immunity in Vitro Aspects) and M114 (Red Blood Cell Metabolism) were added [102].

**JULY 18:** NASA Administrator Dr. Thomas O. Paine approved the change from the "wet workshop" concept to the "dry workshop" concept for the Orbital Workshop by signing a Project Approval Document change request. Dr. Paine's approval of the "dry workshop" concept followed a May 27, 1969, Apollo Applications Program review presentation to the administrator concerning the "dry workshop" alternative [103].

**JULY 22:** NASA announced plans to launch the Workshop and Apollo Telescope Mount



**WET WORKSHOP DETAIL**

together in 1972, using the first two stages of the Saturn V in place of the Saturn I Wet Workshop. The Workshop would be outfitted on the ground and would arrive in a 235-mile circular orbit equipped for immediate occupancy by astronauts and with the ATM attached. Program objectives would remain the same as when NASA intended to use the

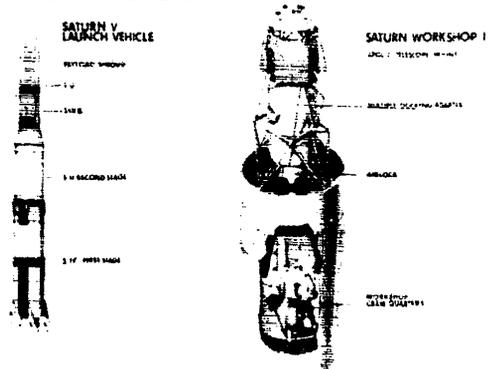
Saturn IB second stage as the 1971 Workshop to provide an environment in which man could live and work for extended periods in space and to study man's physiological and psychological responses and capabilities in space. As a result of the Apollo Program success the Saturn V hardware from that program would be available for this revised plan [104].

### SIGNIFICANT WET-TO-DRY WORKSHOP CHANGES

<u>MULTIPLE DOCKING ADAPTER</u>	<ul style="list-style-type: none"> <li>● DELETE EXPERIMENT STORAGE</li> <li>● ADD APOLLO TELESCOPE MOUNT CONTROLS AND DISPLAYS</li> </ul>
<u>AIRLOCK MODULE</u>	<ul style="list-style-type: none"> <li>● ADD TOTAL MISSION ATMOSPHERIC GAS STORAGE</li> <li>● DELETE SCIENTIFIC AIRLOCK</li> <li>● SHROUD CONFIGURATION CHANGED</li> <li>● ADD APOLLO TELESCOPE MOUNT DEPLOYMENT MECHANISM</li> </ul>
<u>ORBITAL WORKSHOP</u>	<ul style="list-style-type: none"> <li>● SUBSTITUTE COLD GAS ATTITUDE CONTROL SYSTEM FOR OLD HOT GAS SYSTEM</li> <li>● PREINSTALL ALL EQUIPMENT, EXPENDABLES, AND EXPERIMENTS</li> <li>● ADD SCIENTIFIC AIRLOCK</li> </ul>
<u>LUNAR MODULE ASCENT STAGE</u>	<ul style="list-style-type: none"> <li>● DELETED</li> </ul>

### **SIGNIFICANT WET-TO-DRY WORKSHOP CHANGES**

#### **AAP-1 LAUNCH CONFIGURATION**



**SATURN V WORKSHOP**

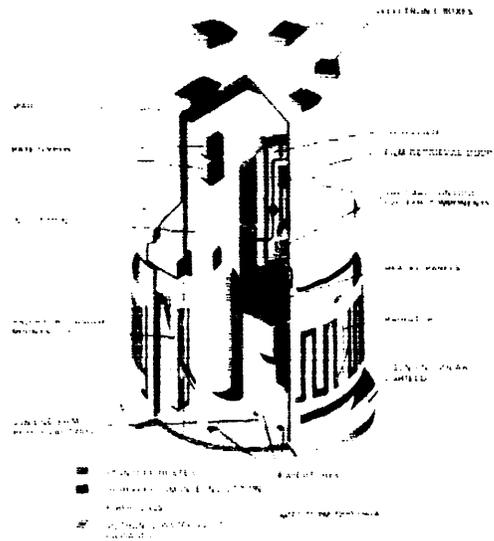


PAYLOAD SHROUD

**JULY 23:** The contract with Grumman Aircraft Corporation for the modification of a LM ascent stage for use with the ATM was terminated. The LM ascent stage was no longer needed when it was decided to put the workshop with the ATM attached in orbit with the Saturn V vehicle [105].

**JULY:** At MSFC Donald R. Bowden was assigned as Chief, Engineering Branch, Saturn Workshop Project, Saturn/Apollo Application Program Office, as announced by William K. Simmons, Project Manager [106].

**AUGUST 1:** NASA awarded a 1,170,000-dollar contract to the Martin Marietta Corporation, Orlando, Florida, for certain flight hardware to be used in the Apollo Applications Program. The assignment, which was expected to take 18 months for completion, called for fabrication, testing, and delivery of 15 Saturn V Workshop rate gyro processors, a module test set, and the retrofit of 22 Apollo Telescope Mount gyro processors. The gyros would provide precise attitude control of the Workshop cluster including the Apollo Telescopes Mount. Work under the contract would be performed at the contractor's facility in Orlando [107].



ATM EXPERIMENT CANISTER

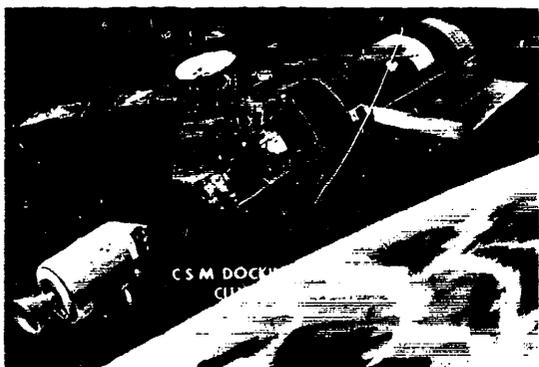
**AUGUST 8:** MSFC modified a contract with the McDonnell Douglas Astronautics Company for continued work on two airlock modules, tests, and checkout of the modules, systems, documentation, and logistics support. Cost was estimated at 87,450,000 dollars, and the work would be performed primarily at the McDonnell Douglas Eastern Division in St. Louis but also would involve some effort at the three manned space flight centers: MSFC, KSC, and MSC. One airlock was already undergoing tests at MSFC [108].

**AUGUST 8:** The cluster caution and warning and fire detection system for the OWS was increased by the addition of an emergency warning system [109].

**AUGUST 8:** A letter contract between MSFC and the McDonnell Douglas Astronautics Company was definitized to provide for two Saturn V Workshops. The first one was

## August 1969

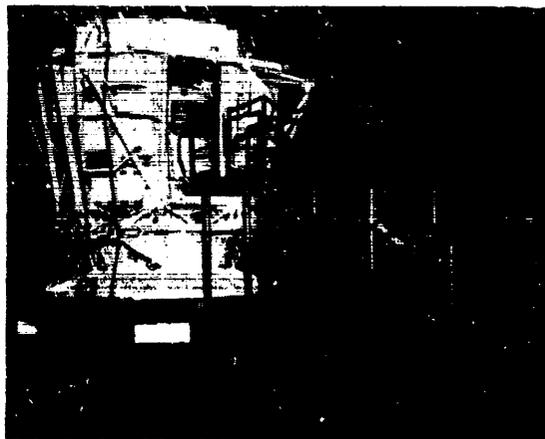
scheduled for launch into low earth orbit in 1972. The second Workshop would initially serve as a backup. The Workshop would be a converted S-IVB stage in which astronauts could live and work for periods up to 8 weeks. The estimated cost of this cost-plus-fixed-fee/award-fee contract was 97,340,000 dollars. The contract would run through July 1972, and work would be performed at the McDonnell Douglas Western Division at Huntington Beach, California [110].



**CSM DOCKING TO CLUSTER IN ORBIT**

**AUGUST 12:** Plans were finalized for an Apollo Telescope Mount Extravehicular Activity (EVA) Review to be conducted August 19-21 at MSFC. More than 100 engineers and scientists would be expected to attend the review. Participants expected included astronauts, ATM experiment principal investigators, and representatives from NASA Headquarters, Manned Spacecraft Center, and Kennedy Space Center. The topic to be discussed would be an approach to EVA for ATM film retrieval. A full-scale ATM mockup would be used for the review. The ATM, or manned solar observatory, would be one of the major Apollo Applications Program elements being developed by MSFC. The ATM, launched in conjunction with the Saturn V Workshop, would be orbited in 1972 by a Saturn V launch vehicle. A three-man Apollo spacecraft,

launched by a Saturn IB rocket, would rendezvous in orbit with the Workshop. The astronaut crew would live in the Workshop and conduct a variety of solar experiments with the ATM equipment for 28 days. Later revisits of up to 56 days were planned [111].



**ATM MOCKUP AT MSFC**

**AUGUST 13:** NASA released its AAP "Launch Readiness and Delivery Schedule ML-17" According to this new schedule there would be seven Saturn IB and two Saturn V launches with two dry Workshops flown on Saturn V vehicles, and two ATM's planned. The first Workshop launch would be in July of 1972 [112].

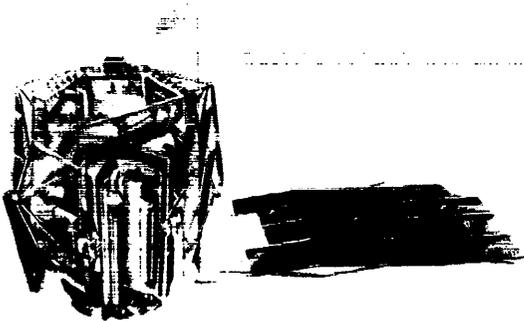
**AUGUST:** At MSFC Rein Ise, Apollo Telescope Mount Project Manager, formalized the following appointments [113]:

Charles H. Chambers, Chief,  
Engineering Branch

James M. Igou, Chief, Control  
Equipment Branch

William C. Keathley, Chief,  
Experiments Branch

**SEPTEMBER 9:**As the modifications required to convert to the Saturn V Workshop were being developed, the decision was made to make the ATM's attitude control system responsible for the cluster attitude control [114].



#### ATM CANISTER CUT

**SEPTEMBER 24:** The Manned Space Flight Experiment Board approved the following changes to the list of corollary experiments for the Apollo Applications Program. Experiments D019 (Suit Donning and Sleep Evaluation), D020 (Alternate Restraints Evaluation), and D022 (Expandable Structures for Recovery) were deleted [115].

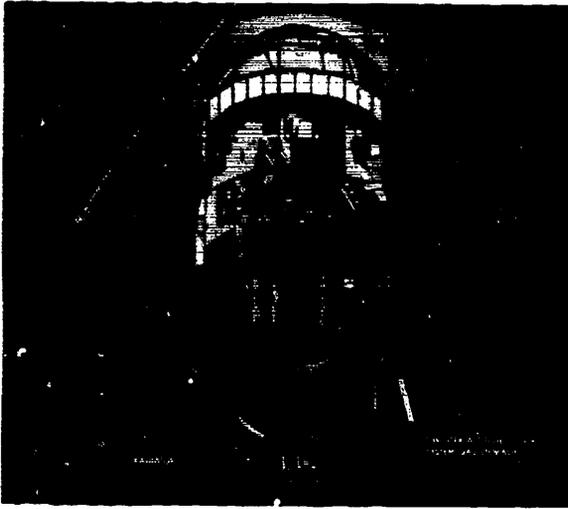
**OCTOBER 5-11:** The International Astronautical Federation (IAF) held its 20th Congress in the Mar del Plata, Argentina. Dr. George E. Mueller, NASA Associate Administrator for Manned Space Flight, gave Invited Lecture October 6 on Apollo program, space benefits, Apollo Applications program,

and lunar exploration. Apollo Applications program would "...study the earth through the use of a six-lens multispectral camera installation. On Apollo 9 some of the rudimentary work was done using four lenses. Fifty percent more kinds of information will be brought back by the crews of Apollo Applications. Because almost everything on earth has a different reflective quality, as distinctive as a signature or a fingerprint, results from this photographic exploration can be expected to yield rich rewards. Many of the earth sciences look to this kind of information for answers to previously unanswerable questions. Hydrologists are interested in discovering not only the depth, but also the temperature of the waters of the world, and these conditions can be ascertained from space. Warm water attracts certain species of fish, so fishermen are also interested in these experiments" [116].

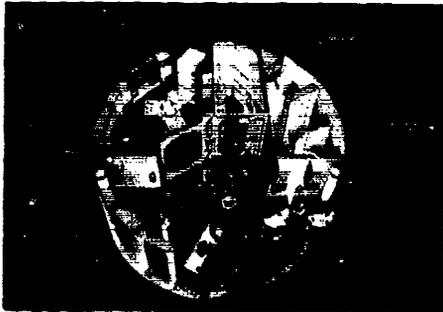
**OCTOBER 7:** MSFC signed a new contract with the General Electric Company's Apollo Systems Division in Huntsville, Alabama, for work in connection with the Apollo Applications Program. Under the 10,751,000-dollar contract, GE would provide electrical support equipment for the Apollo Telescope Mount and launch systems for the Saturn V Workshop multiple docking adapter and airlock. The contract called for the work to be performed at Huntsville, Alabama, at the Manned Spacecraft Center in Houston, Texas, at Daytona Beach, Florida, and at the NASA-Kennedy Space Center in Florida. Work on the project was to be completed by June 30, 1972 [117].

**OCTOBER 15:** The wardroom concept (combining a crew eating and recreation area) was approved, and the DOD sleep compartment experiment assigned to the Saturn I Workshop was deleted to allow additional space for the wardroom [118].

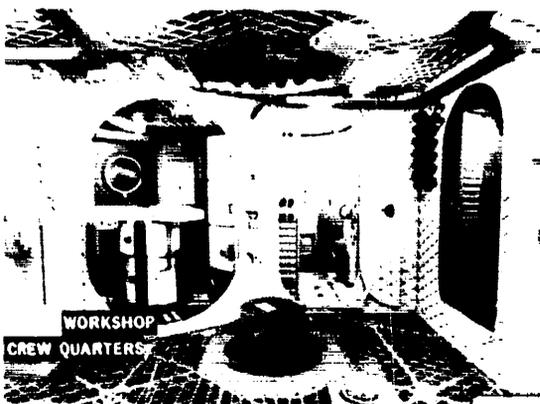
## October – November 1969



**ORBITAL WORKSHOP**



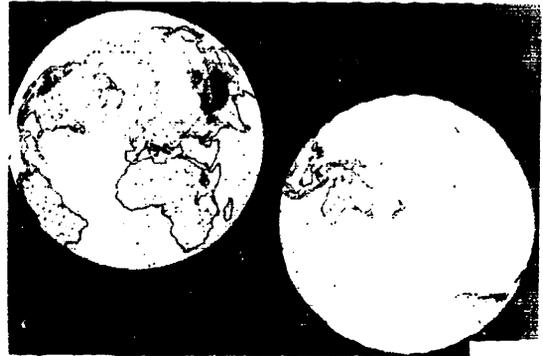
**CREW QUARTERS LAYOUT**



**WORKSHOP CREW QUARTERS**

**OCTOBER 31:** NASA decided to add television cameras for interior coverage of the Saturn Workshop [119].

**NOVEMBER 3:** NASA decided to change the launch inclination of the Saturn Workshop to 50 degrees [120].



### **FIFTY-DEGREE INCLINATION COVERAGE**

**NOVEMBER 7:** The decision was made to add a teleprinter in the airlock module of the OWS to permit the astronauts to have printed instructions furnished to them during mission operations [121].

**NOVEMBER 20:** MSFC announced that an 8-million-dollar letter contract had been negotiated between NASA and the McDonnell Douglas Corporation, Huntington Beach, California, for two sets of structural components for the third stage (S-IVB) of the Saturn V launch vehicle for use in fabrication of the Saturn V manned orbital Workshop. The work would be completed by January 1972. The structural components would be produced at the Huntington Beach, California, plant [122].

**NOVEMBER:** At MSFC Charles L. Wood was assigned as Manager, Program Control Office, Saturn/Apollo Applications Program Office, upon Jack Swearingen's reassignment to Director's Office, Science & Engineering [123].

## December 1969

**DECEMBER 2-4:** The Cluster Systems Review was conducted at MSFC. Review teams consisting of representatives from Headquarters, MSFC, MSC, KSC, prime contractors, and experiment Principle Investigators reviewed such areas as mission requirements, attitude control, thermal/ECS, instrumentation and communications, structures, electrical, and crew systems [124].

**DECEMBER 4:** During the Cluster Systems Review December 2-4, 1969, NASA decided for better reliability of the cluster electrical power to parallel the ATM electrical power with the rest of the cluster through the airlock module [125].

**DECEMBER 8:** The Manned Space Flight Experiment Board approved the following changes to the list of corollary experiments for the Apollo Applications Program. Experiment S190 (Multispectral Photographic Facility) was added [126]. The following experiments were deleted:

S069 X-Ray Astronomy

S039 Day-Night Camera System

S043 IR Temperature Sounding

S049 IR Interferometer Spectrometer

S050 IR Temperature Profile Radiometer

S051 Daytime Sodium Cloud

S075 Elec-Scan Microwave Radiometer

S100 Metric Camera

S101 Multiband Photography

S102 Dual Channel Scanner-Imager

S103 Short Wavelength Spectrometer

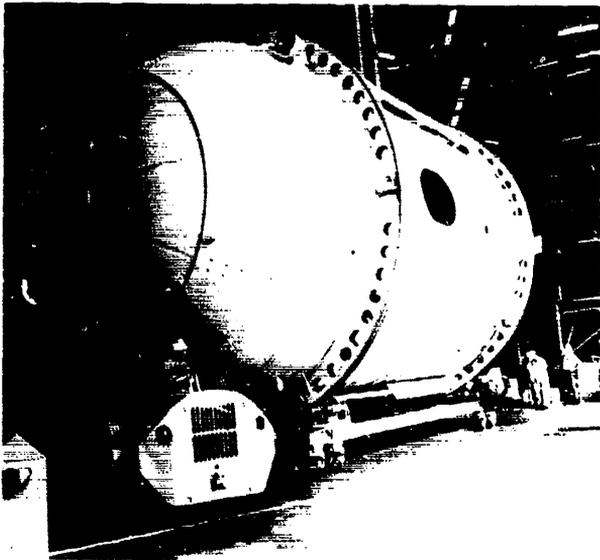
S104 Microwave Temperature Sounder

M423 Hydrostatic Gas Bearing

**1970**

1970

**JANUARY 2:** MSFC shipped the test version of the Saturn V vehicle's third stage to the McDonnell Douglas plant at Huntington Beach, California, for modification. The S-IVB stage went from MSFC to the West Coast aboard the Super Guppy aircraft. The stage, formerly identified as the S-IVB 500 F or facilities stage, would be converted into a Saturn V Workshop "dynamics test article." Once the modification would be completed, the stage would be used in the Apollo Applications Program's dynamics and acoustics testing activity. The stage was formerly a part of the Saturn V facilities vehicle used to check out manufacturing, testing, and launching facilities early in the Apollo/Saturn V Program. MSFC received the stage from KSC about January 1969 [127].

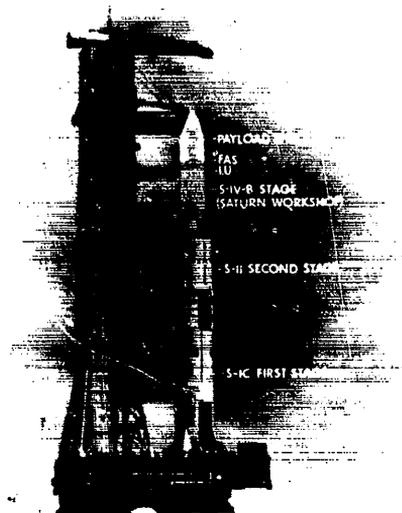


**WORKSHOP DYNAMIC TEST ARTICLE  
AT MDAC-WD**

**JANUARY 23:** NASA released the AAP "Launch Readiness and Delivery Schedule ML-18," which moved the scheduled AAP-1 launch date to November 15, 1972, but with a target launch date of July 15, 1972 [128].

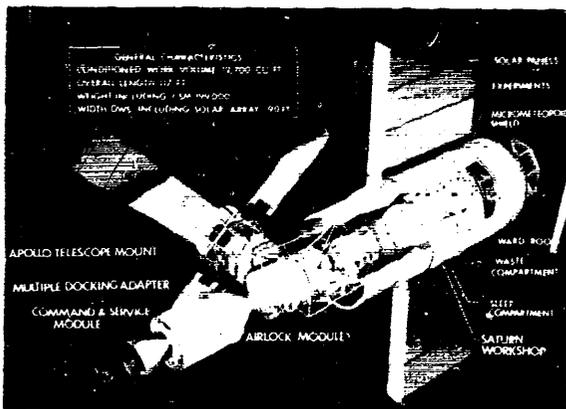
**FEBRUARY 12:** The House Committee on Science and Astronautics' Subcommittee on NASA Oversight released its "Manned Space Flight: Present and Future" report. One of the conclusions drawn by this staff study was that after 1974 the U.S. would have no capability for lifting manned payloads over 60,000 pounds into space and would have only three vehicles that could lift 60,000 pounds payload unless Saturn V production was resumed or a substitute was developed. Also, the U.S. would have no long-duration manned earth-orbital capability after 1973 without extension of the orbital workshop program or initiation of development of the Space Station [129].

**FEBRUARY 20:** NASA Headquarters announced a change of the program name from Apollo Applications Program to Skylab Program. The Skylab Program would be designed to make maximum use of the existing space hardware developed for the Apollo lunar-landing series. Included in the cluster of components making up the Skylab would be the Workshop, airlock, a multiple docking adapter, and an Apollo Telescope Mount [130].

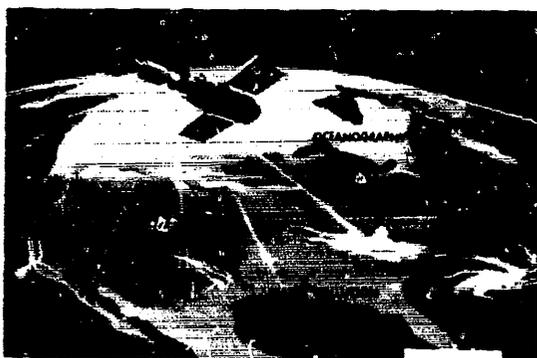


**SKYLAB PAYLOAD LAUNCH  
CONFIGURATION**

March 1970



**SKYLAB CLUSTER**



**EARTH OBSERVATION STUDIES**

**MARCH 1:** Dr. Wernher von Braun left MSFC to become NASA's Deputy Associate Administrator for planning in Washington, D.C. Dr. Eberhard Rees, who had served as Deputy Director, Technical, since 1963, became director of the Marshall Center [131].

**MARCH 9:** The Manned Space Flight Experiment Board approved changes to Earth

Resources Experiment for the Skylab Program [132].

Experiments added:

- S191 Infrared Spectrometer
- S192 10-Band Multispectral Scanner
- S193 Microwave Scatterometer, Altimeter, and Radiometer

Experiments deleted:

- S005 Synoptic Terrain Photography
- S006 Synoptic Weather Photography

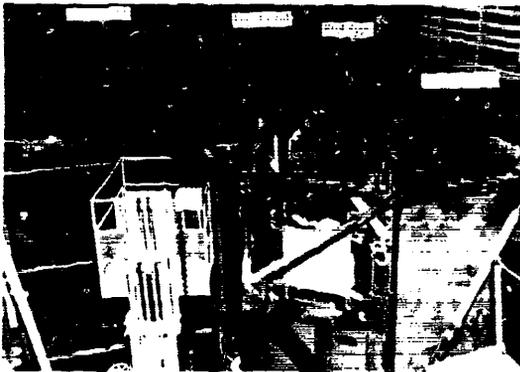
**MARCH 31:** Representatives of three NASA Centers gathered in Huntsville to start a 4-day tour of Skylab government and contractor facilities. Those on the tour from MSC included Dr. Robert R. Gilruth, Dr. Christopher C. Kraft, Kenneth S. Kleinknecht, Clifford E. Charlesworth, Dr. Maxime E. Faget, Sigurd A. Sjoberg, Dr. Donald K. Slayton, George Abbey, Robert F. Thompson, Dr. C.A. Berry, Eugene F. Kranz, and Cadwell Johnson. On the tour from KSC was General Thomas W. Morgan, and from MSFC were Dr. Eberhard Rees, Ed Mohlere, Lee B. James, Ludie Richard, Dr. F.A. Speer, Dr. Walter Haeussermann, Karl L. Heimburg, Brooks Moore, Leland F. Belew, and Jack Lee. At the Marshall Center, the group viewed Skylab work in several laboratories. In the afternoon they departed for a 3-day tour of contractor facilities. Companies visited were McDonnell Douglas Astronautics Company, St. Louis, Missouri, Martin-Marietta Corporation, Denver, Colorado, and North American Rockwell Corporation and McDonnell Douglas in the Los Angeles area. The group also visited the

## March - May 1970

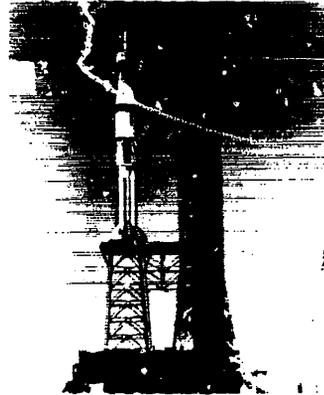
NASA-Flight Research Center at Edwards, California [133].

MARCH: Overton S. Tyson was assigned as MSFC Resident Manager, NASA Resident Management Office, Saturn/Apollo Applications Program Office, located at the McDonnell Douglas Astronautics Corporation at Huntington Beach, California. Clifford L. Flora was assigned as Deputy Resident Manager [134].

MAY 15: MSFC announced that NASA had decided to launch Saturn IB and Saturn V vehicles scheduled for the 1972-1973 Skylab Program from Launch Complex 39 at Cape Kennedy. The decision to conduct Saturn IB launches at LC-39, rather than Complex 34, Cape Kennedy, was reached after a comprehensive study of the capabilities and costs of both locations, according to Skylab Program officials. Normally, only Saturn V's would be launched from LC-39 [135].



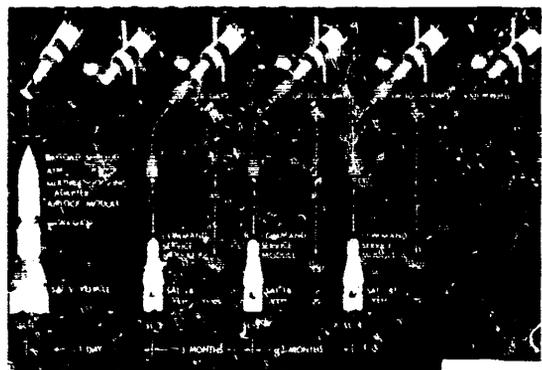
ASSEMBLY OF ATM RACKS AT MSFC



SKYLAB SATURN IB LAUNCH CONFIGURATION



MDA TEST ARTICLE IN FABRICATION AT MSFC

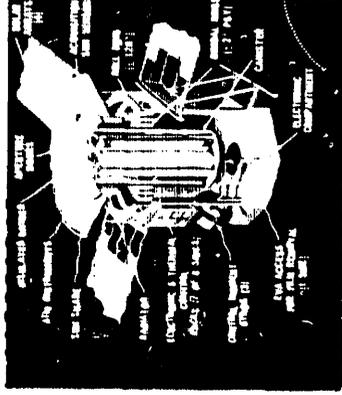


SKYLAB ACTIVATION AND OPERATION

## May - June 1970

**MAY 26:** The ATM Critical Design Review (CDR) was completed with the CDR Board meeting at MSC. This review gave final approval to the ATM design [136].

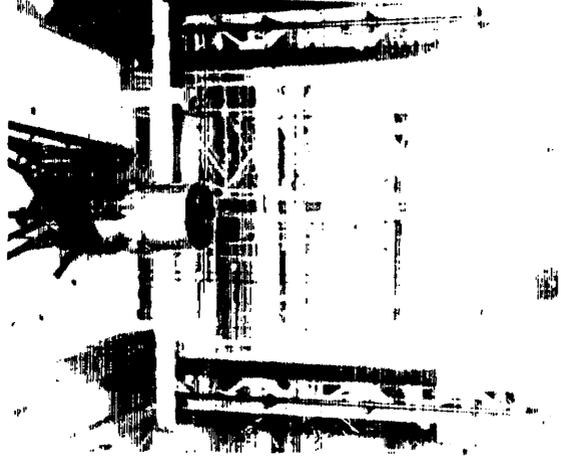
- CHARACTERISTICS
- WEIGHT
- CENTER OF GRAVITY
- MOMENT OF INERTIA
- STABILITY
- CONTROL
- PERFORMANCE
- TEST PROGRAM



### APOLLO TELESCOPE MOUNT (ATM)

**MAY 26:** The airlock module static structural qualification testing was completed at MSC with the successful completion of the 125-percent liftoff loads test. The airlock structural test article used for this test was later modified to become the dynamic test article used in the payload assembly vibroacoustic test at MSC [137].

**JUNE 3:** The ATM Thermal Systems Unit was delivered from MSC to MSC. It was subjected to the temperature and vacuum extremes of a space environment in the MSC thermal vacuum chamber as part of the qualification program on the ATM [138].



### MATING OF AIRLOCK AND MDA TEST ARTICLES FOR STATIC STRUCTURAL TEST AT MSFC

**JUNE 11:** The Manned Space Flight Experiment Board approved the following changes to the list of corollary experiments for the Skylab Program [139].

#### Experiments Added:

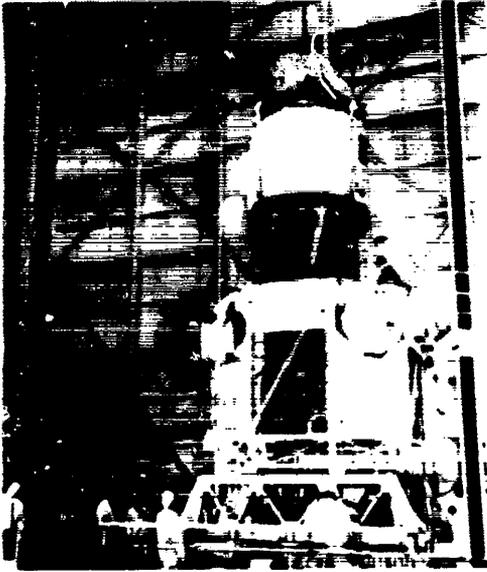
- S183 UV Panorama
- M133 Sleep Monitoring

#### Experiments deleted:

- T017 Meteoroid Impact and Erosion
- T021 Meteoroid Velocity

**JUNE 18:** MSC awarded a contract modification to Martin-Marietta Corporation for work on the Skylab Program. The \$3,460,726-dollar contract was for continuing work on the Skylab's multiple docking adapter, and the work was being done by Martin-Marietta's Denver facility. This modification covered design, development,

June - July 1970

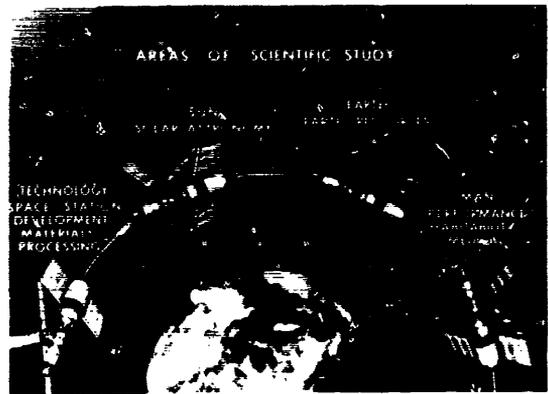


**FINAL ASSEMBLY OF THE ATM THERMAL SYSTEMS UNIT AT MSFC**

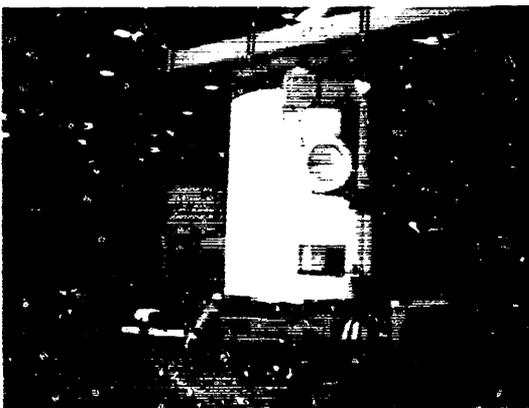
fabrication, assembly, integration, and testing of the multiple docking adapter equipment. MSFC made the basic docking adapter structure. At the time of this contract modification, Martin was the prime contractor to MSFC for the Skylab Program payload integration [140].

**JUNE 29-30:** NASA held a "Skylab and Beyond" press briefing and tour of production facilities at MSFC. William C. Schneider, Skylab Program Director, said that the project was "in the very critical phase of firming up our designs." Three missions were planned for the 8-month lifetime of the 48-foot-long workshop [141].

**JUNE:** The appointment of Thomas F. Ryan as Deputy Manager, Program Control Office, Skylab Program Office, was formalized at MSFC [142].



**SKYLAB PROGRAM**



**MDA DYNAMIC TEST ARTICLE BEING LOWERED ONTO FACTORY TRAILER**

**JULY 2:** In a letter, NASA Associate Administrator for Manned Space Flight, Dale D. Myers, wrote Dr. Rees requesting participation in a review of the Apollo and Skylab Programs. He wrote that the review would be a follow-up to the report of the Apollo 13 Review Board which included recommendation No. 9 that, in essence, called for a reassessment of all Apollo spacecraft subsystems, and the engineering organizations responsible for them at MSFC and its prime contractors. Mr. Myers added that the scope of the coverage under the recommendation had been expanded to include all elements of Apollo (spacecraft, launch vehicle, and GSE) as well as Skylab. It would be a major review,

## July 1970

followed by other reviews, with more than 100 MSFC personnel participating directly in various stages of the reviews [143].

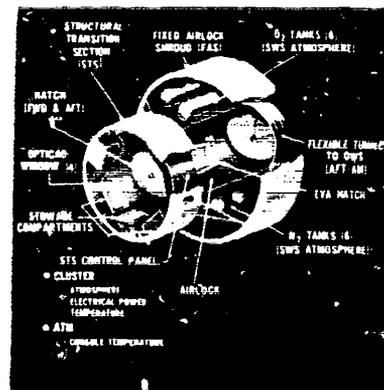
**JULY 7:** Dr. Wernher von Braun, NASA Deputy Associate Administrator for Planning, and eight other NASA Headquarters officials began attending a series of meetings at MSFC to discuss the Skylab, the High Energy Astronomy Observatory (HEAO), and future scientific space projects. Although a new and relatively small project as of this date, the HEAO signified a type of payload that could become one of the major scientific experiments in early phases of the Shuttle flight program [144].

**JULY 8:** MSFC modified an existing contract with Martin Marietta Corporation, Denver, Colorado, for additional work on the Skylab Program. The 1,863,000-dollar contract modification covered development, implementation, and operation of a change integration and configuration control system for the Skylab Program. The Marshall Center directed the Skylab Program. At the time of this announcement, Martin was the Skylab Payload integration contractor for MSFC. This action brought the contract total to 104,946,600 dollars [145].

**JULY 17:** MSFC issued a Contract Change Order to McDonnell Douglas Aircraft Corporation, Western Division (MDAC-W) changing the food management concept from a soft to a canned food package, which provides for additional food storage. Modification to the wardroom table for mounting a new serving tray, which provides heated cavities for heating the food, was also included in the change [146].

**JULY 23:** MSFC modified an existing contract with McDonnell Douglas Astronautics Company for additional work on the Skylab airlock. Under the contract, McDonnell Douglas' Eastern Division at St. Louis, Missouri, was building two Skylab airlock modules, one for flight and one for spare. The

contract modification totaled 38,979,000 dollars. The airlock module being developed at the St. Louis facility was a 55-foot-diameter circular tunnel attached to the top of the Workshop. It would provide the major work area and support equipment required to activate and operate the Workshop and would also form a passageway for the astronauts to move from the Apollo command module and multiple docking adapter into the Workshop. The airlock could also be depressurized and sealed off for exit into space outside the vehicle [147].

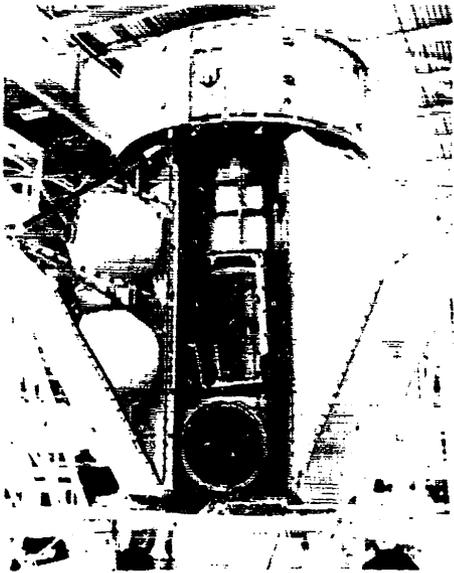


### CHARACTERISTICS

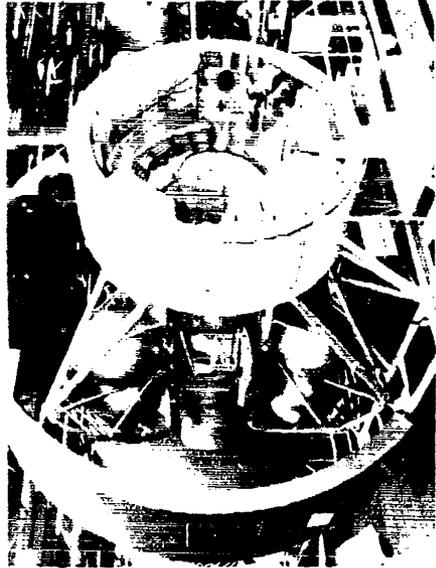
- WEIGHT LOADED TO ESCAPE PROGRAM: 49,000 LB
- DIAMETER: 50.5 METERS (167 FT)
- LENGTH TOTAL: 51.0 METERS (167 FT)
- VOLUME HABITABLE: 1,400 METERS CUBED

### AIRLOCK MODULE (AM)

**JULY 27:** Approximately 175 representatives of government and industry participated in a Skylab airlock/multiple docking adapter crew station review in St. Louis, Missouri. The week-long review occurred at the McDonnell Douglas Astronautics Company. Topics discussed included storage areas, equipment, and crew operation. Astronauts attending the review conducted "walkthroughs" of airlock and multiple docking adapter mockups. The airlock and multiple docking adapter would be major elements of the Skylab cluster that would include a large solar observatory and crew quarters for long stays in space. McDonnell Douglas was developing the airlock. The multiple docking adapter structure was being built by MSFC, and Martin Marietta,

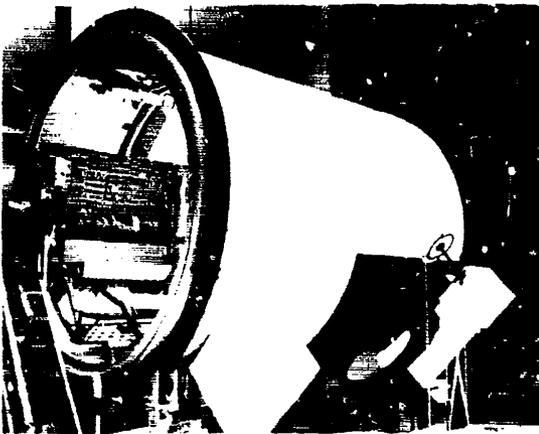


**AIRLOCK FLIGHT UNIT IN FABRICATION  
AND ASSEMBLY**

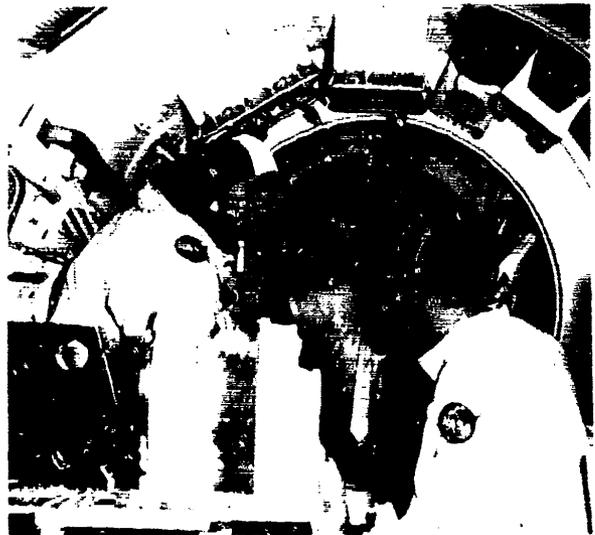


**AIRLOCK MOCKUP PRIOR TO CREW  
STATION REVIEW**

Denver Division, was integrating equipment and experiments. MSFC was directing the Skylab development [148].



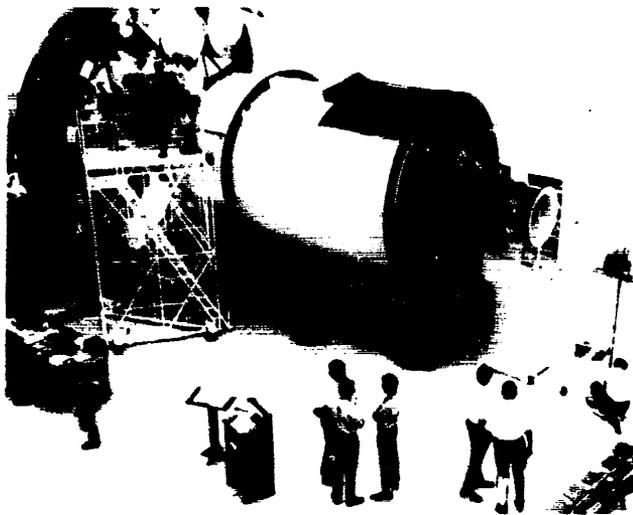
**MDA MOCKUP PRIOR TO CREW STATION  
REVIEW**



**AIRLOCK MODULE INTERIOR DURING  
CREW STATION REVIEW**

## August 1970

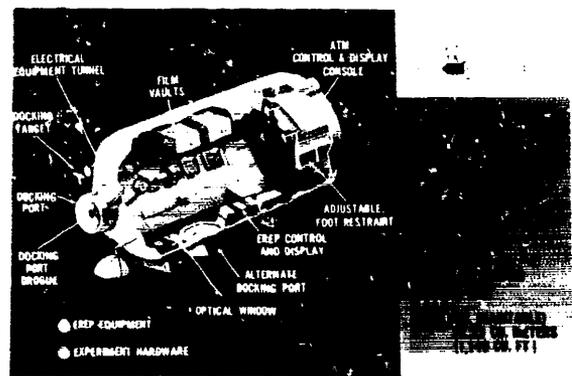
**AUGUST 12-14:** Lee B. James, charged with responsibility for the Apollo 13 review at MSFC, felt that the review had benefits beyond the recommendations of the Apollo 13 Review Board: "I think a bigger purpose of the overall review was we found out in the Apollo Program that occasionally the entire program needs to be shaken down by the very top management in an overall review. . .that had seldom happened in Skylab, and this Apollo 13 review gave an occasion to really spend some time from this one point of view to go through the entire Skylab program, and to really check it in the end from the top management point of view. We get a lot of good out of these things; they turn up different things if there isn't any other way to do this. . .I would watch for occasions such as this to give the program an end-to-end review, and have a good orderly review just for the good of the program [149]."



**AIRLOCK/MDA MOCKUPS DURING CREW STATION REVIEW**

**AUGUST 24:** More than 150 representatives of NASA and industry conducted a week-long Skylab review at the Martin-Marietta facility in Denver, Colorado. Skylab officials were conducting a critical design review of the Skylab's multiple docking adapter. This was

scheduled as the final technical review before approval would be given for manufacturing flight hardware. Skylab officials from MSFC, MSC, KSC, and NASA Headquarters attended. The MSFC delegation was headed by F.M. Drummond, Manager of the Airlock/MDA Project, and Myrl Sanders, Deputy Manager. Martin-Marietta was the Skylab payload integration contractor for the Marshall Center. While MSFC was building the multiple docking adapter external structure, Martin was integrating the experiments. Other contractors included the Bendix Corporation and McDonnell Douglas Corporation, builder of the airlock and the Workshop [150].



**MULTIPLE DOCKING ADAPTER (MDA)**

**AUGUST 28:** A group of MSFC engineers successfully completed a week-long testing of Skylab program hardware in simulated weightlessness aboard a USAF KC-135 four-engine-jet research aircraft. Tests included operation of flight-configuration doors for film cassette compartments, retrieval and replacement of film cassettes, and evaluation of handrails and foot restraints. The KC-135 was flown in parabolas, with 30 seconds of weightlessness achieved on each parabola in a technique that most nearly duplicated zero-g [151].

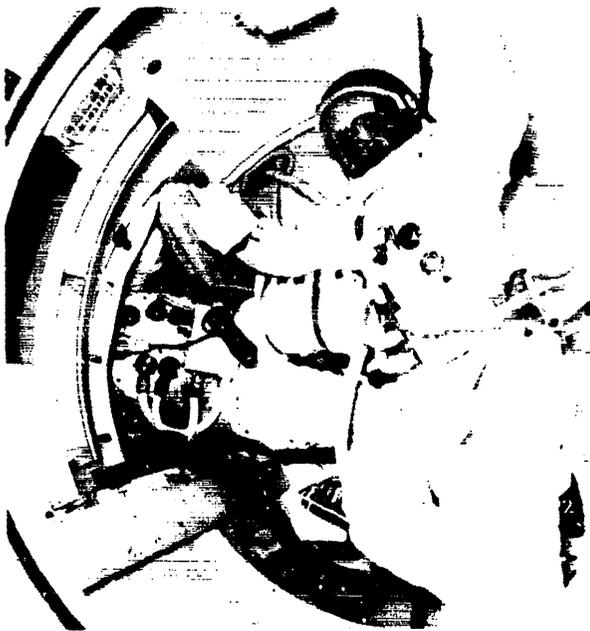
## August – September 1970



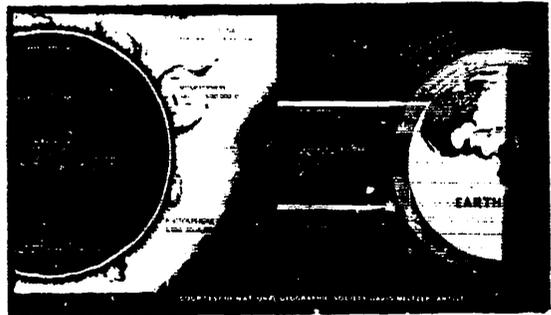
**ATM CENTER WORK STATION FILM CASSETTE REPLACEMENT IN ZERO G**

the July 15, 1972, target date scheduled under the earlier ML-18 schedule [152].

**SEPTEMBER 3:** MSFC awarded the Ball Brothers Research Corporation, Boulder, Colorado, a 195,000-dollar space agency contract to study a solar telescope for possible inclusion in a manned solar observatory on a future flight opportunity. At the time of this contract award, NASA's first manned solar observatory (Apollo Telescope Mount) was scheduled for launch in 1972 as an element of the Skylab cluster. The space agency had asked Ball Brothers to define requirements for a 26-inch solar telescope as a major new experiment to be included in a follow-on observatory [153].

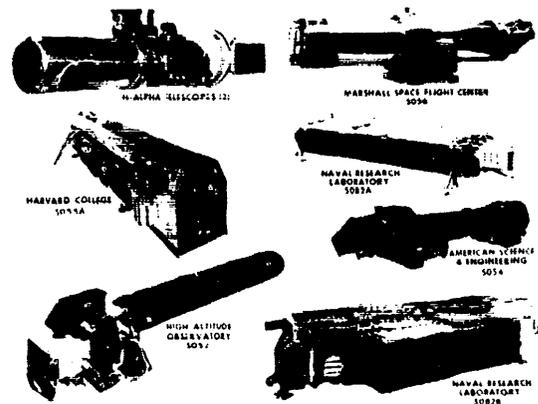


**AIRLOCK ZERO-G SIMULATION IN KC-135 AIRCRAFT**



**ATMOSPHERIC ABSORPTION OF SOLAR EMISSIONS**

**AUGUST 31:** NASA published its "Skylab Launch Readiness and Delivery Schedule ML-19," which moved the scheduled Skylab launch date to November 1, 1972, but dropped



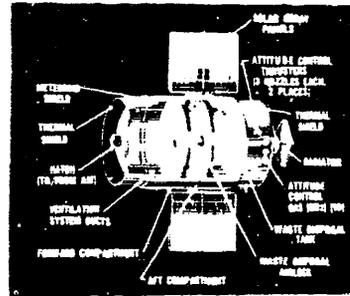
**ATM EXPERIMENTS**

## September 1970

SEPTEMBER 8: MSFC announced that the flight design of the Saturn Workshop, a part of the Skylab program, would be accepted in a series of important reviews scheduled for the next few weeks at MSFC in Huntsville and at Huntington Beach, California. Government engineers, astronauts, and industry representatives would determine if changes were necessary before the final approval would be given for completing the flight Workshop currently scheduled for launch into earth orbit in 1972. First in the review series would be an astronaut procedures review on September 9-10 at MSFC. Astronauts would study many proposed Workshop procedures in a mockup. A critical design review would be conducted September 14-18 at the McDonnell Douglas Astronautics Company facility at Huntington Beach, California. McDonnell Douglas was manufacturing the Workshop for the space agency. More than 200 government and industry representatives were expected to participate in the critical design review. A Workshop crew station review would be held September 21-24 at MSFC. Astronaut crewmen would walk through many of the Skylab tasks in this review.

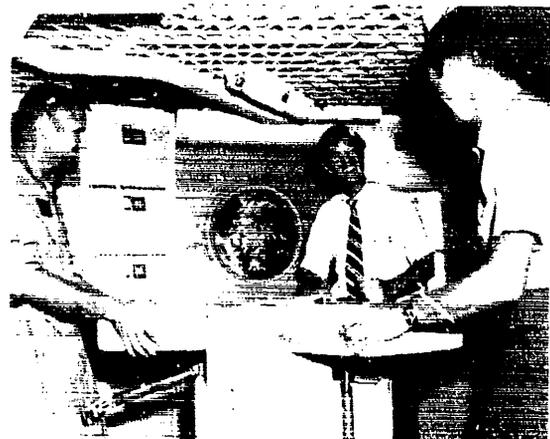
Results of the reviews would be considered in a Workshop Critical Review Board meeting October 2 at Huntington Beach, with Leland Belew, Manager of the Skylab Program Office, presiding. Many of the same participants would have taken part in a preliminary review of the results September 28-29 at Huntington, Beach, with William K. Simmons, Jr., Manager of the Workshop project under Belew, acting as chairman [154].

SEPTEMBER 21: A Saturn workshop crew station review began at MSFC as a part of the Skylab Program. A group of nine astronauts headed by Richard Truly participated in the week-long review conducted in a mockup at MSFC. Government and industry engineers monitored the astronaut crewmen's progress and commented as they "walked through" many of the workshop tasks. Medical experiments scheduled for the Skylab flight were reviewed during the week. This crew



**ORBITAL WORKSHOP (OWS)**

station review followed a critical design review conducted September 14-18 at the McDonnell Douglas Astronautics Company facility at Huntington Beach, California. At the time of this review, McDonnell Douglas was manufacturing the workshop for the space agency. Results of the critical design and crew station reviews would be considered in a Workshop Critical Review Board meeting October 2 at Huntington Beach, California. Results of these reviews would be used to determine if changes were necessary before the final approval was given for completing the flight workshop currently scheduled for launch into earth orbit in 1972 [155].



**ASTRONAUTS OVERMYER AND SCHWEICKART IN OWS WARDROOM DURING CREW STATION REVIEW**



**ASTRONAUT OVERMYER ON ERGOMETER  
IN OWS CREW QUARTERS DURING  
CREW STATION REVIEW**

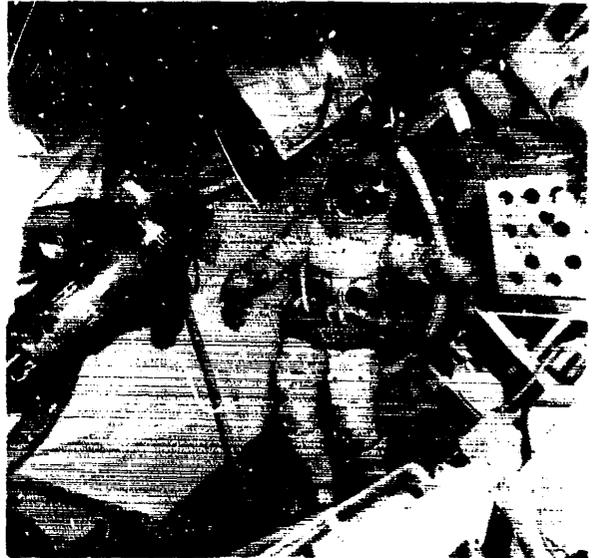
**SEPTEMBER 25:** MSFC modified an existing contract with Martin Marietta Corporation for work on the Skylab Program. Under this contract change, which covered Apollo Telescope Mount support at MSC and MSFC, Martin Marietta would receive \$1,895,300. This was a cost-plus-award-fee type contract [156].

**OCTOBER 5:** The Manned Space Flight Experiment Board approved the following changes to the list of corollary experiments for the Skylab Program. Experiments S194 (L-Band Radiometer) and T002 (Manual Navigation Sightings) were added. Experiment M508 (Human Mass Measurement Device) was deleted [157].

**OCTOBER 21:** Russian Cosmonauts Sevastyanov and Nikolayev were briefed on the Skylab mission during a tour of MSFC [158].



**COSMONAUTS SEVASTYANOV AND  
NIKOLAYEV WITH INTERPRETER  
BARKSKY BEING BRIEFED BY DR. REES,  
MR. BELEW, AND MR. HARDY IN  
WORKSHOP MOCKUP**



**COSMONAUT SEVASTYANOV AT AIRLOCK  
EVA WORK STATION IN NEUTRAL  
BUOYANCY FACILITY AT MSFC**

## October – November 1970

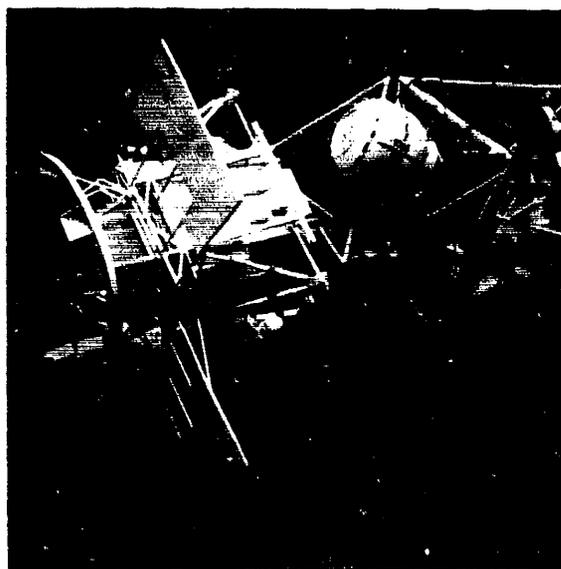
**OCTOBER 26-27:** U.S.-U.S.S.R. talks on the possibilities for compatible rendezvous and docking arrangements in space were held in Moscow between the NASA delegation headed by MSC Director, Dr. Robert R. Gilruth, and a Soviet Academy of Sciences team headed by Academician Georgy I. Petrov. During the exchange of basic information on docking systems, NASA officials described Gemini and Apollo techniques, procedures, and docking adaptors and the Skylab project. The Soviet team described plans for a future system similar to Apollo's, with a tunnel between the spacecraft to accommodate docking apparatus. Agreement was reached that 12 scientific technical elements required further joint study, including guidance systems for rendezvous, docking hardware, coordinate systems, and reference markings [159].

**NOVEMBER 17:** Two Skylab Program reviews were underway at MSFC. An extravehicular activity (EVA) critical design review was being held at the Skylab mockup area and the Neutral Buoyancy Simulator. Charles W. Mathews, Deputy Associate Administrator, Office of Manned Space Flight, NASA Headquarters, was chairman of a Skylab Subsystems Review Team meeting on November 17. The EVA review, which started on November 16, included astronaut performances under normal earth gravity in the Saturn Workshop mockup and simulated weightlessness in the Neutral Buoyancy Simulator. Ten astronauts from the Manned Spacecraft Center, headed by Russel Schweickart, participated in the review activities on November 16. The review lasted a week.

The Skylab Subsystems Review Team meeting opened on November 17 with an inspection of the Skylab mockup area. Chairman Mathews and the team members also toured simulation facilities in Astrionics and Manufacturing Engineering Laboratories and viewed Apollo Telescope Mount hardware being assembled in the Manufacturing Engineering Laboratory. The review team ended its activities on November 19 [160].

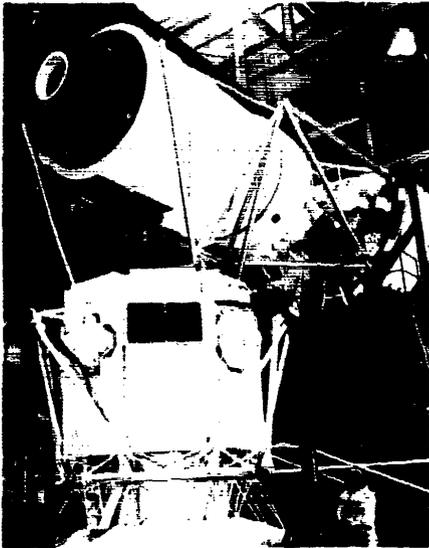


**SKYLAB-ATM FILM RETRIEVAL**



**NEUTRAL BUOYANCY DURING EVA CDR**

## November – December 1970

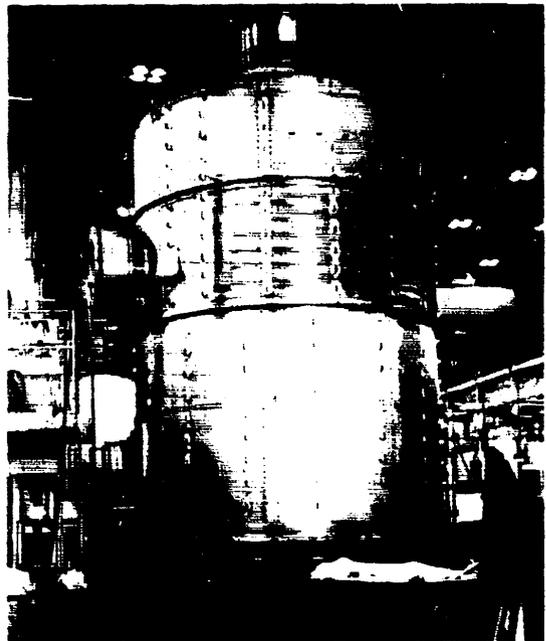


**AIRLOCK, MDA, AND ATM MOCKUPS  
USED DURING EVA CDR**



**ATM SUN END WORK STATION MOCKUP  
USED DURING EVA CDR**

NOVEMBER 18: The flight model of the Skylab multiple docking adapter was flown from MSFC to Martin Marietta Corporation Space Center in Denver, Colorado, aboard the Super Guppy aircraft. It would be outfitted with controls and display panels for solar astronomy and earth resource experiments, storage vaults for experiment film, and a thrust-attitude control system. When completely equipped, the adapter would be mated with the Skylab airlock flight version at McDonnell Douglas Astronautics Company in St. Louis, Missouri, and the unit would perform simulated mission in the altitude chamber [161].

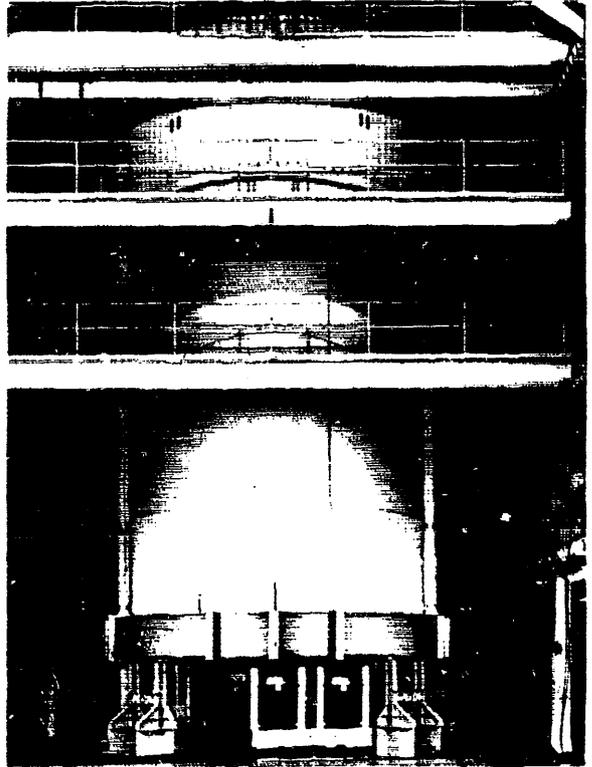


**MDA FLIGHT ARTICLE AT MSFC PRIOR  
TO DELIVERY TO MMC**

DECEMBER 2: MSFC announced that a Saturn Workshop would be shipped on

## December 1970

December 4 from the McDonnell Douglas Astronautics Company facility at Huntington Beach, California, to MSC in Houston, Texas, for extensive ground tests. This Workshop was a ground test version of one which would be used in the Skylab Program to accommodate teams of three astronauts for stays up to 28 days in earth orbit. Called a "dynamic test article," the Workshop model would undergo a series of tests at MSC to verify its bending and vibration characteristics. McDonnell Douglas technicians loaded the Workshop aboard the "Point Barrow" for shipment to the Michoud Assembly Facility in New Orleans, Louisiana. The Point Barrow was scheduled to arrive in New Orleans on December 17. The Workshop would be loaded aboard a NASA barge at Michoud for shipment on December 30 to Houston. It was scheduled to arrive at the Houston port on January 5. MSFC was directing the Workshop development program [162].



**WORKSHOP DYNAMIC TEST ARTICLE IN VIBRATION TEST AT MSC**



**WORKSHOP DTA ON TRANSPORTER BEING LOADED ON USNS POINT BARROW**

DECEMBER 16: The Manned Space Flight Experiment Board approved the following changes to the list of corollary experiments for the Skylab Program. Experiment M507 (Gravity Substitute Workbench) was deleted [163].

DECEMBER 18 31: As NASA neared the end of 1970, there was much activity relative to the moment of Saturn stages. A few days before Christmas, two Saturn V flight stages (S-II-15 and S-IVB-512) were enroute to KSC, and a Saturn Workshop test model would soon complete its journey to MSC in Houston. MSFC had shipped both the vehicles. On December 18, 1970, the ship Point Barrow reached the Michoud Assembly Facility in New Orleans from California carrying the Saturn Workshop and the S-IVB-512. The Workshop was unloaded for later shipment to MSC while the S-II-15, which had been brought from MTF the previous day, was loaded aboard the Point Barrow for the remainder of the trip to KSC. The ship would reach KSC on December 20

where the two stages would be stored until needed for flight missions.

The Workshop vehicle, destined for MSC, known as the "dynamic test article," would leave Michoud December 31 aboard the MSFC barge "Orion." It would be unloaded at a NASA dock at Clear Lake, near MSC, the first such hardware to move to the Houston center in this manner, which was to arrive on January 5, 1971. The Workshop model would undergo a series of tests at MSC to verify its bending and vibration characteristics. Another Saturn V stage (S-II-13) was taken from a test stand on December 18 at MTF. The stage would be prepared during the following two weeks for shipment to KSC. It was scheduled to be loaded aboard the barge "Poseidon" on December 30 at MTF. The barge would leave Michoud on December 31 for the trip to KSC [164].



**PAYLOAD SHROUD SEPARATION TEST AT PLUM BROOK**

**DECEMBER 20:** The Payload Shroud full-size test article weighing 26,000 pounds was tested at the Lewis Research Center's Plum Brook Facility. The shroud separated into four sections using the same method as the flight unit would use in space. Large nets were used to catch the four sections [165].

**DECEMBER 22:** MSFC announced that highlights of 1970 at MSFC included: Launch of an Apollo/Saturn V vehicle (AS-508), renaming the space agency's embryonic Space Station project to Skylab, continuing work on the Space Shuttle and Space Station, doing early planning on the unmanned astronomy satellite (HEAO), and Dr. Eberhard Rees being named MSFC director. These and other highlights combined to make the first year of the decade an eventful one at NASA's largest field center [166].

**DECEMBER 23:** An assessment of the feasibility of providing crew rescue capability for Skylab was conducted by the three MSF centers during 1970. This culminated in a



**SKYLAB CREW RESCUE COMMAND MODULE**

Headquarters decision to provide a limited capability based on failure of CSM return capability while docked to the Saturn Workshop. The rescue vehicle for the first two Skylab missions will be the next Skylab vehicle in-flow at KSC. Upon receipt of a rescue call, the in-flow CSM would be prepared for launch after some minor modifications to permit a two-man crew going up and a five-man crew returning [167].

1971

## January – February 1971

1971

**JANUARY 1:** A Saturn V second stage (S-II) left MTF and stopped briefly at Michoud Assembly Facility before proceeding aboard the barge "Poseidon" for KSC where it was scheduled for arrival on January 6. The S-II-13 would be stored at the KSC Vehicle Assembly Building until readied for launch. This stage would be a part of the two-stage Saturn V (vehicle 513) that would launch the Skylab into earth orbit in late 1972 [168].

**JANUARY 15:** A group of potential Skylab crew members were taking a special course in solar physics designed to provide them with a background which would enable them to efficiently operate the Apollo telescope mount. The course was divided into extensive reviews of the introduction to solar phenomena, the quiet sun, the active sun, and flares and explosive phenomena. Studies of the sun in real time were made possible by utilizing closed circuit TV to bring pictures from MSC's solar telescope to the classroom [169].

**JANUARY 19:** NASA announced that it was requesting proposals from potential U.S. and foreign experimenters for investigations of data to be acquired from earth resources experiment package (EREP) to fly on manned Skylab spacecraft in late 1972. Data could be used to appraise value and direct applications of space observations in agriculture, geography, forestry, geology, hydrology, oceanography, and cartography. Objectives of EREP were to extend use of sensors; use man to observe, discriminate, and select study areas; and provide early source of unique research data for analysis [170].

**JANUARY 26:** An ATM Experiments Principal Investigator (PI) meeting was conducted at Boulder, Colorado, on January 26 and 27. This was one of a series of meetings between MSFC, the ATM developer, and the scientists who proposed the six solar astronomy experiments, to insure total agreement on experiment objectives,

development, operations and data analysis. MSC participated in these reviews to ensure crew and mission operations requirements were met. Among the significant items in this review were: an update of the Martin Marietta Corporation facilities proposed to support Skylab was presented; the solar data from ground observatories required to support mission operations were described by National Oceanic and Atmospheric Administration (NOAA) personnel and their recommendations were agreed to by the ATM PI's with the stipulation that additional data were needed; and the ATM film study reported areas to be worked such as temperature control and radiation protection for film [171].

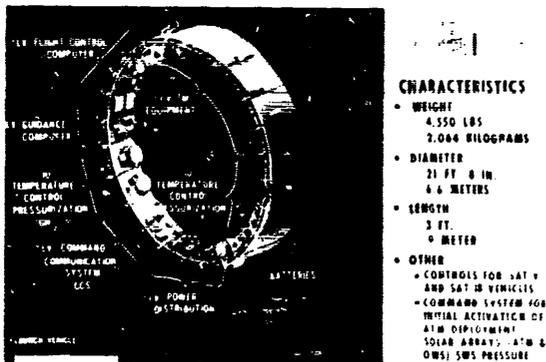
**JANUARY 29:** The first low-level acoustic run, designed to check out all systems and instrumentation on the Orbital Workshop, was successfully completed as scheduled. Acoustic testing was scheduled to continue after a data review [172].

**FEBRUARY 8:** A high-level advisory group responsible for guiding NASA in all aspects of mission safety opened a two-day meeting at MSFC. The Aerospace Safety Advisory Panel, which was appointed by the NASA Administrator, was headed by Dr. Charles D. Harrington, President, Douglas United Nuclear, Incorporated, Richland, Washington. At MSFC the group discussed safety aspects of the lunar roving vehicle, the Skylab cluster of spacecraft, and the proposed reusable space vehicle (space shuttle) [173].

**FEBRUARY 10:** The Kennedy Space Center awarded a \$917 900 contract to the Holloway Corporation of Titusville, Florida, to construct a launcher-pedestal that would be used during the upcoming Skylab Program. The 127-foot-tall pedestal would be adapted to an existing Launcher-Umbilical Tower so that manned Saturn IB space vehicles could be launched from facilities now supporting the larger Saturn V rockets. The Holloway Corporation contracted to construct the launcher-pedestal in 180 days after receiving its Notice to Proceed [174].

## February – March 1971

**FEBRUARY 23:** MSFC granted to the International Business Machines Corporation a contract modification for the manufacture of instrument units (IU) for Saturn launch vehicles. Valued at 14,407,743 dollars, the modification would extend IBM's delivery schedule for IU's through December 31, 1973, to be compatible with the extended Apollo and Skylab Program launch schedules. IBM was under NASA contract to build 27 IU's for Saturn vehicles: 12 Saturn IB's and 15 Saturn V's. Ten of the Saturn IB units and 12 Saturn V units had been completed. All work was being done at the company's facilities in Huntsville, Alabama. The original IU contract had been granted to IBM in March 1965 for the fabrication, assembly, checkout, and delivery of the 27 units and related support functions [175].



### INSTRUMENT UNIT (IU)

**MARCH 1:** Dr. George M. Low, Acting NASA Administrator, presented the NASA FY 1972 budget request to House Committee on Science and Astronautics: FY 1972 projects – including Apollo 15 and 16, two Mariner spacecraft, first ERTS satellite, and continuing work toward future flights of Apollo 17, Skylab, earth resources and ATS satellites, and Viking probes – represented “the fulfilment of enterprises of the 1960’s, the tailing off to completion of work in progress for many years. By 1974 the number of NASA space launches

per year will have declined from 26 in 1966 to 8. After the Skylab missions in 1973, we face at least four years in which there will be no United States manned flight.”

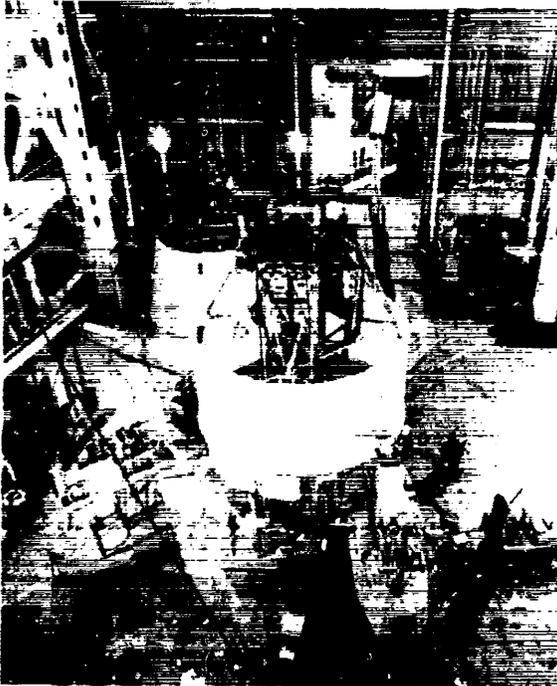
“Five years ago there were over 390 000 people in industry employed on NASA work. By the end of FY 1971 that figure will be about 108 000. The decline will continue for a few more months, but we expect it to start increasing by the middle of FY 1972, with the end-of-the-year total being about equal to that at the beginning.” U.S. was “running a serious risk of losing too much of the aerospace capability that is an essential ingredient of our long term national strength and security” [176].

**MARCH 10:** MSFC modified a contract with Chrysler Corporation to authorize additional work in the Saturn IB program. Chrysler was the prime contractor for the first stage of the Saturn IB, which it assembled at the Michoud Assembly Facility in New Orleans. Under the current 29,136,622-dollar modification, the company would maintain nine Saturn IB boosters in storage. Three of the nine vehicles were for the Skylab program and would be launched in 1973. Those three, plus a fourth that would serve as a backup, would be maintained and modified as necessary under terms of this contract. Prelaunch checkout of the Skylab vehicles would also be accomplished under this modification. The period of performance was from January 1, 1971, to August 15, 1973. Six of the vehicles were located at the Michoud Facility, and the other three were at MSFC in Huntsville [177].

**MARCH 11:** Orbital Workshop (OWS) vibration test objectives, test article status, test facility preparations status, and test schedules were reviewed by MSFC and MSC during a test readiness review for the Skylab OWS vibration test at MSC on March 11. The Test readiness review board concluded, upon resolution of one test constraint, that the initial run could proceed as scheduled for March 19, 1971 [178].

## March – April 1971

**MARCH 15:** Workmen began the setup of the ATM structural rack and payload shroud section for the ATM simulated flight loads test to occur in mid-1971 at MSFC [179].

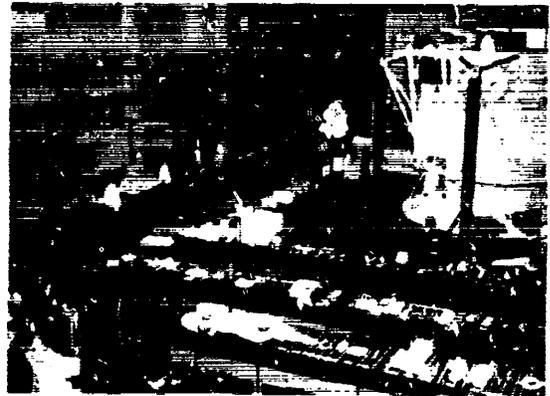


**SETUP FOR ATM SIMULATED FLIGHT LOADS TEST (ATM VIBRATION UNIT IS IN BACKGROUND)**

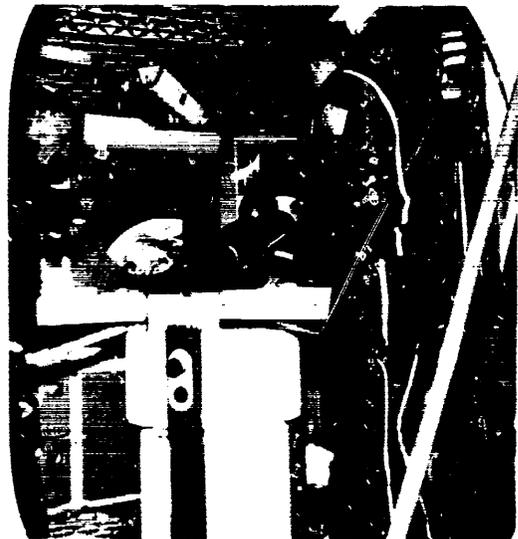
**APRIL 1 & 2:** The Skylab Subsystems Review Team, chaired by Charles W. Mathews, held a 2-day meeting at KSC to review the action items status which resulted from the November 17-19, 1970, review of Skylab subsystems. Action items reviewed included such areas as the qualification program, testing, contamination, safety, single-point failures, protection of flight systems with limiting devices on GSE, cluster control and ATM pointing, and extreme temperature effects on components [180].

**APRIL 12:** Space engineers and astronauts studied Skylab Workshop stowage facilities at a review at MSFC. Astronauts taking part performed workshop activation procedures,

reviewing each compartment's storage areas and running through deactivation procedures. Astronauts participating included Alan Bean, Charles Conrad, Joseph Kerwin, Paul Weitz, Walter Cunningham, Gerald Carr, Russell Schweickart, William Lenoir, and Richard Truly [181].



**CREW COMPARTMENT STORAGE REVIEW  
BENCH CHECK COMPONENT LAYOUT**



**ASTRONAUTS SAMPLING FOOD IN WARD ROOM DURING WORKSHOP CREW COMPARTMENT STORAGE REVIEW**

## April – May 1971

**APRIL 13:** NASA published "Skylab Launch Readiness and Delivery Schedule ML-20," which moved the scheduled Skylab launch date from November 1, 1972, to April 30, 1973 [182].

**APRIL 15:** Proposed Skylab rescue mission profile requirements were: the trajectory planning for a rescue mission would be the same as the nominal Skylab mission; nominal mission duration from launch to recovery would be limited to 5 days; the orbital assembly would maneuver to provide acquisition light support for the rescue Command and Service Module (CSM); the rescue CSM would be capable of rendezvous without VHF ranging; landing and recovery would be planned for the primary landing area; transfer of the crew from the MDA to the CSM would be in shirtsleeves (no extravehicular activity); the KSC rescue launch response times would vary from 10 to 45½ days depending on the transpired time into the normal checkout flow [183].

**MAY 3:** Approval has been given by Headquarters of a Skylab external TV system. The system involves the use of the Experiment T027 photometer extendable boom to extend a television camera and motorized lens system through either of the scientific airlocks in the Workshop. The previously baselined Skylab color television system consists of an Apollo television camera and strategically located television input stations that permits observation of experiments and crew activity. It provides virtually unlimited internal coverage. The addition of the camera on the Experiment T027 boom will permit observations of targets of scientific interest; earth, EVA operations, and operations of various spacecraft assemblies [184].

**MAY 3:** The Manned Space Flight Experiment Board approved the following changes to the list of corollary experiments for the Skylab Program. Experiment D021 (Expandable Airlock Technology) was deleted [185].

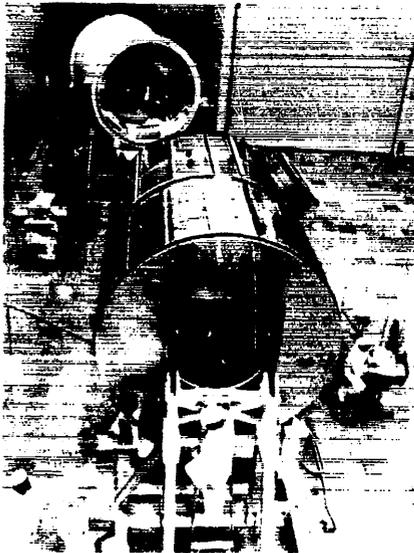
**MAY 6:** A Critical Design Review (CDR) of the EVA film transfer boom was conducted at Fairchild-Hiller on May 6. The projected payload was 85 pounds, an increase of 15 pounds since the Preliminary Design Review (PDR). There were no significant action items uncovered by the review, nor were any schedule problems identified [186].

**MAY 19:** Space agency executives directing the Skylab Program began participating in the Skylab Senior Management Tour at Martin Marietta Corporation on May 18. Skylab executives saw work underway at Martin Marietta before moving on to visit West Coast contractors. The group then toured North American Rockwell at Downey and McDonnell Douglas Astronautics Company facilities at Huntington Beach. A second half of the tour scheduled for May 25-26 would see Skylab executives visiting McDonnell Douglas facilities in St. Louis in the morning, then in the afternoon they would visit MSFC, and then visit KSC on May 26. A similar Skylab managers' tour had been held last year. Executives taking part in all or a part of the tour included Charles W. Mathews, Deputy Associate Administrator for Manned Space Flight; William C. Schneider, Director Skylab Program, NASA Headquarters; Dr. Eberhard Rees, MSFC Director; Dr. William R. Lucas, MSFC Deputy Director, Technical; Leland F. Belew, MSFC's Skylab Program Manager; Dr. Kurt H. Debus, KSC Director; Miles Ross, KSC Deputy Director; Raymond L. Clark, KSC Director of Technical Support; Christopher Kraft, Jr., MSC Deputy Director; Kenneth S. Klinknecht, Manager of the Skylab Program at MSC; and Astronauts Alan L. Bean and Charles Conrad of MSC.

Also participating from industry were Walter F. Burke, President and Chief Operating Officer of McDonnell Douglas Astronautics Company; Dr. Ben G. Bromberg, Vice President and General Manager, and Raymond A. Pepping, Vice President and General Manager of the Skylab Program, both of MDAC Eastern

May 1971

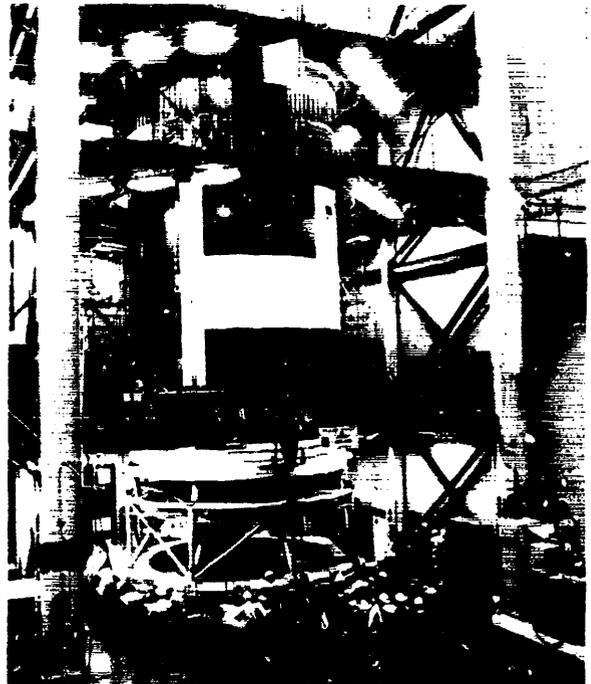
Division; Fred J. Sanders, Program Manager, Skylab Orbital Workshop, MDAC Western Division; and George Jeffs, Vice President Space Division, and Joseph P. McNamara, President Space Division, both of North American Rockwell Corporation [187].



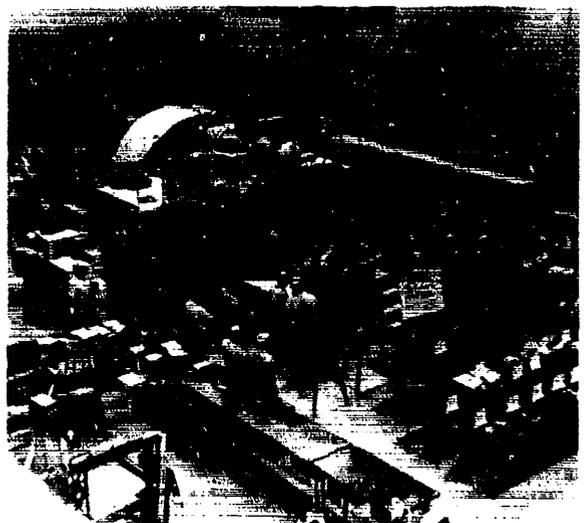
**MDA FLIGHT UNIT IN ASSEMBLY AT MMC  
(DEVELOPMENT UNIT IN BACKGROUND)**

**MAY 25:** A plan was initiated whereby PI's for Skylab experiments would be enabled to view Apollo 15, 16, or 17 mission operations. This would enable key Skylab personnel to obtain necessary exposure to MSC operational procedures prior to the initiation of the mission operations phase of the Skylab Program Office [188].

**MAY:** At MSFC Mr. Waite, Manager Experiment Development and Payload Evaluation Project, Skylab Program Office, announced the appointment of Henry B. Floyd, III as his Deputy [189].

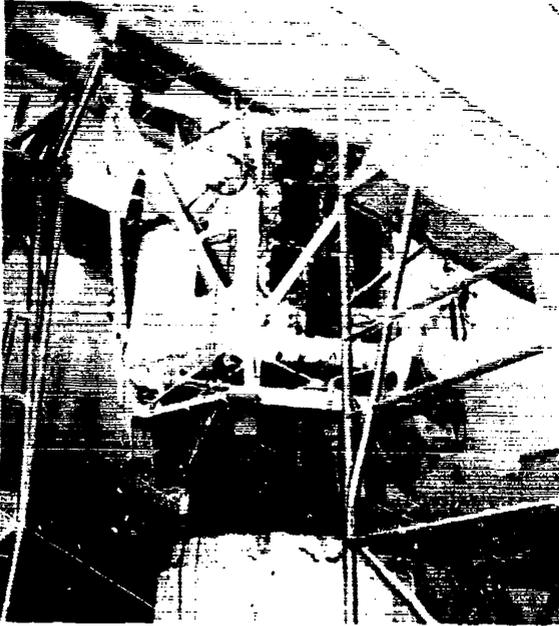


**WORKSHOP FLIGHT UNIT IN ASSEMBLY  
AT MDAC-WD**



**AIRLOCK FLIGHT UNIT IN ASSEMBLY  
AT MDAC-ED**

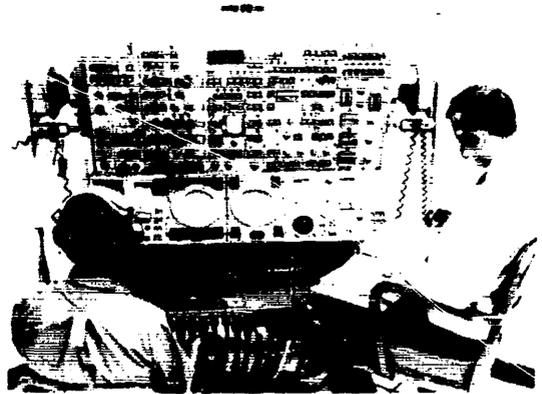
June 1971



**FINAL ASSEMBLY OF ATM PROTOTYPE  
AT MSFC**

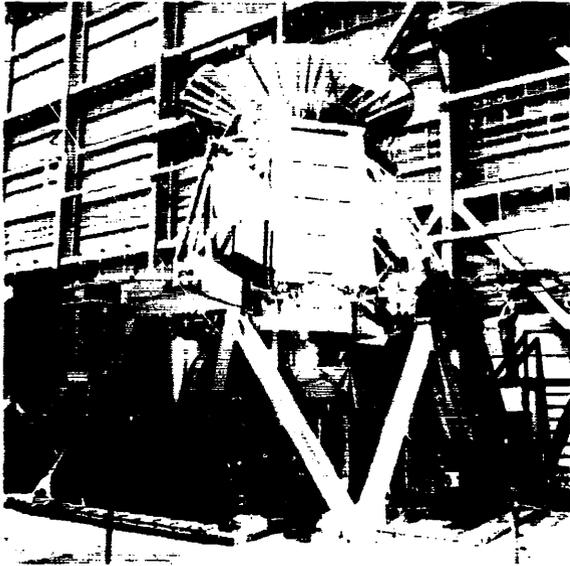


**ATM FLIGHT EXPERIMENT NRL-A IN  
CHECKOUT AT MSFC**



**ATM PROTOTYPE CONTROLS AND DISPLAY  
DURING CHECKOUT AT MSFC**

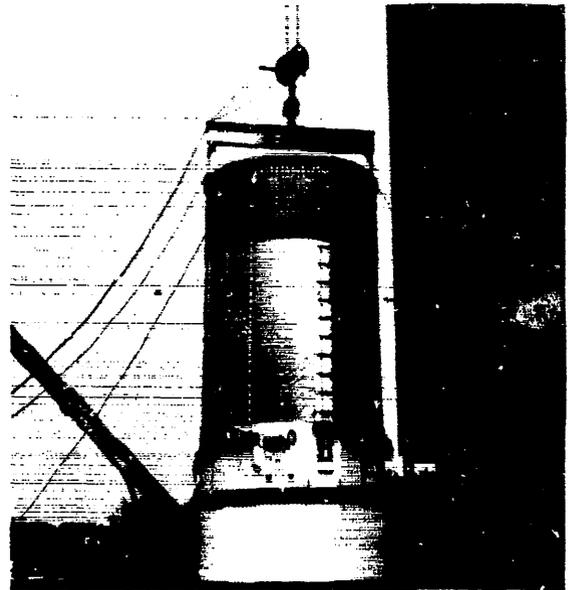
**JUNE 3:** A Skylab Workshop test unit arrived at MSFC aboard the NASA barge "Orion." It came from MSC where it had been through vibration and acoustic testing. This test unit was a ground test version of the Workshop which would be used in the Skylab Program to accommodate teams of three astronauts for stays up to 56 days in earth orbit. While at MSFC the Workshop, called a "dynamic test article," was modified for extensive static structural testing. It was placed in MSFC's huge dynamic test tower for the test series. A 2-month test program was scheduled to start about November 1. Soon after arrival at MSFC, the Workshop was moved to the Product Engineering and Process Technology Laboratory. There it was outfitted with test instrumentation and a simulated meteoroid shield. Technicians also did some minor rework on the inside of the stage. The Astronautics Laboratory at MSFC also conducted tests on the Workshop model. Loads placed on the vehicle simulated the forces which the main structural elements of the Workshop would encounter prior to launch and during launch and orbital flight [190].



**INSTALLATION OF WORKSHOP TEST  
ARTICLE INTO THE DYNAMIC  
TEST TOWER AT MSFC**

**JUNE 7:** In a step toward building orbital space stations, the Soviet Union's manned Soyuz 11 linked up with the space laboratory Salute launched 7 weeks earlier, and three cosmonauts went aboard. The two craft together formed a vehicle 60 feet long, 12 feet in diameter, and weighed 25 tons. Portending an era of orbiting space stations in which MSFC hoped to play a major role, the Russian news agency declared that "A Soviet manned orbital scientific station is functioning." The linkup climaxed a chase through space lasting more than 25 hours. Soyuz 11 streaked into orbit the morning of June 6 and began pursuing Salute, launched April 19. Aboard Soyuz 11 were three cosmonauts: Viktor Patsayev, Vladimir Volkov, and Lt. Col. George Dobrovolsky [191].

**JUNE 17:** Vibration testing was successfully completed on the ATM vibration unit at MSFC. Following vibration testing the unit was prepared for shipment to MSC where it was used in the payload assembly vibroacoustic test [192].



**ATM VIBRATION UNIT IN VIBRATION  
TEST AT MSFC**

**JUNE 21:** Four MSFC engineers took part in discussions with Russian counterparts regarding the possibility of developing compatible space docking equipment. The meeting between U.S. space agency officials and about 20 Russian officials occurred at the Manned Spacecraft Center, Houston, Texas. Attending from MSFC were George Hardy of the Skylab Program Office, Joe Cremin of the Aero-Astroynamics Laboratory, Melvin Brooks of the Astronautics Laboratory, and Robert G. Eudy of the Astrionics Laboratory. Hardy had been in a group of five Americans who initiated these discussions in Moscow last October [193].

**JUNE 23:** NASA announced receipt of more than 600 proposals from potential domestic and international users of data expected from ERTS and Earth Resources Experiment Package to be carried on Skylab. It was the greatest number of proposals for experiments ever received by NASA in response to announcement of opportunity for analysis of space-derived data. ERTS-A would be launched in spring 1972 and ERTS-B in 1973. First Skylab carrying EREP would be launched in 1973. Proposals in response to February invitation had come from more than 550

## June – July 1971

domestic and 80 international sources. They were being evaluated by nine panels of more than 100 scientific experts in various disciplines [194].

**JUNE 25:** Authority to proceed on the ATM Calibration Rocket Program was given to determine the amount of degradation of the Harvard College Observatory and the Naval Research Laboratory experiments data during the Skylab mission. Degradation due to decrease in mirror reflectivity, changes in photographic film sensitivity, gamma and background fogging, aging of filters and gratings could cause misinterpretation of the solar data. To improve the data evaluation, sounding rockets were proposed to launch instruments similar in concept to those in the ATM during the mission after calibration to a known light source. These instruments would be pointed to some of the same solar areas at which the ATM was pointed and the returned data would be compared to the ATM data [195].

**JUNE 30:** Russia's worst space tragedy to date brought quick reassurance from NASA the NASA's Skylab and Space Shuttle programs should not be affected. The tragedy occurred as the three Soyuz 11 cosmonauts died on June 30, 1971, as their spaceship brought them back to earth from the world's first manned orbital space laboratory and a record of nearly 24 days in space. An official announcement said the three spacemen (Lt. Colonel Georgy Dobrovolsky, Flight Engineer Vladislav Volkov, and Test Engineer Viktor Patsayev) completed their flight program the day before and communicated with ground control on their way down. Soyuz 11 made a smooth landing where it was supposed to, the announcement said, but the rescue crew that opened the hatch found the men dead. The announcement published by Tass, the official Soviet news agency, said the cause of the deaths was being investigated. It gave no indication what that might be. In a NASA news conference called on this same date by Dr. George M. Low at 1:30 p.m., Huntsville time,

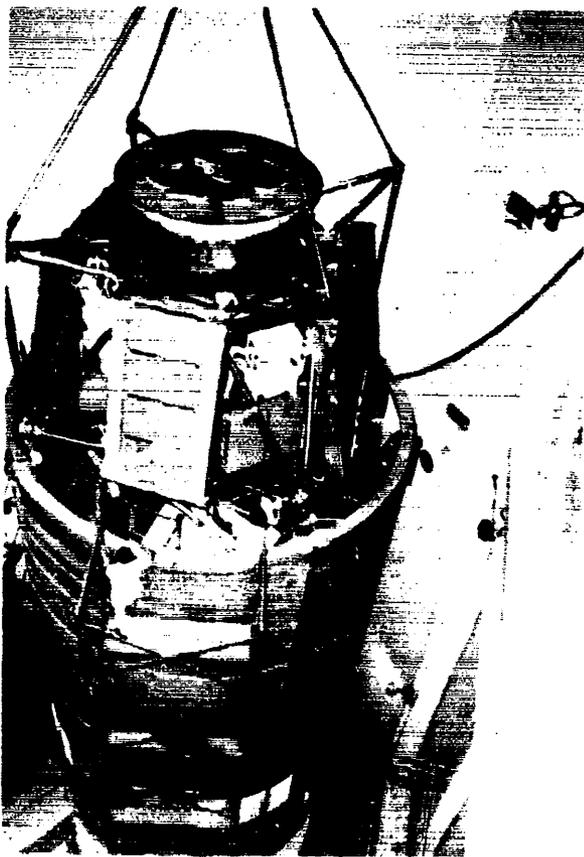
NASA expressed condolences over the death of the three cosmonauts and speculated that it must have been machine failure rather than human failure that caused the accident. Dr. Low indicated that a failure in the environmental control system was one of the prime suspects. He stated that it was very unlikely that this problem in the Soviet's spacecraft would cause a delay in NASA's Shuttle or Skylab programs [196].

**JULY 8 and 9:** The final Skylab Subsystem Review was conducted in Washington, D.C. These reviews, started on November 17, 1970, were an in-depth look at the Skylab Subsystems by NASA top management. NASA Headquarters set the requirement for these as a result of the Apollo 13 Accident Review Board recommendation to ensure that the Skylab Mission had adequate safety and reliability in its development. Mr. Charles W. Mathews was chairman of the team. All formal action items from the previous reviews were closed out in the final meeting [197].

**JULY 16:** NASA approved the award to the Boeing Company of a contract modification for systems engineering and integration work on the Saturn V launch vehicle. The modification was valued at 29,773,858 dollars and would extend Boeing's integration work through December 31, 1972. The basic contract began in September 1964. Included in the modification was work on requirements for Saturn V vehicles that would launch the remaining Apollo lunar exploration missions (Apollo 15, 16, and 17) and the Skylab Program's Saturn workshop. Boeing's systems engineering and integration work at the time of this modification award included requirements and documentation for presettings for onboard computers that determined launch events, propellant loadings for all three vehicle stages, vehicle structural integrity, expected heating environments, range safety, tracking and communication data, and post-flight reconstruction of launch data. Boeing was also MSFC's contractor for manufacture and testing of the first (S-IC) stage of the Saturn V [198].

## July – September 1971

**JULY 20:** The selection of the Centrifugal Separator Urine Collection System, manufactured by Hamilton Standard Company, was made by MSFC and approved by NASA Headquarters in lieu of the Two Bag System, manufactured by Fairchild Hiller Company. The selection was made primarily for its ability to meet the required 2-percent volume measurement accuracy and less storage area required for bags [199].



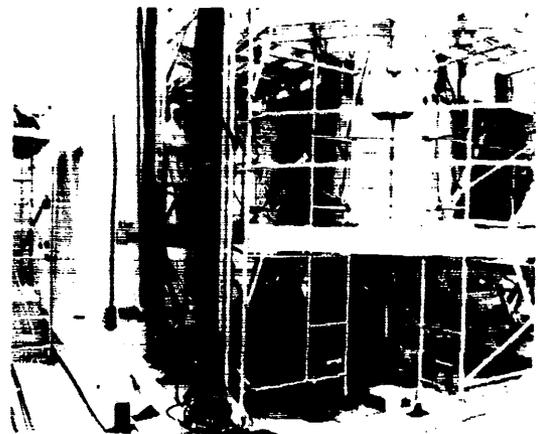
**STACKING OF SKYLAB PAYLOAD  
ASSEMBLY AT MSFC FOR  
ACOUSTIC TESTING**

**JULY 29:** Skylab payload assembly acoustic test requirements, test article status and discrepancies, facility preparations status, and safety assessment were reviewed by MSFC and

MSC during a test readiness review meeting held at MSC. The board ruled that the test operations could proceed as planned [200].

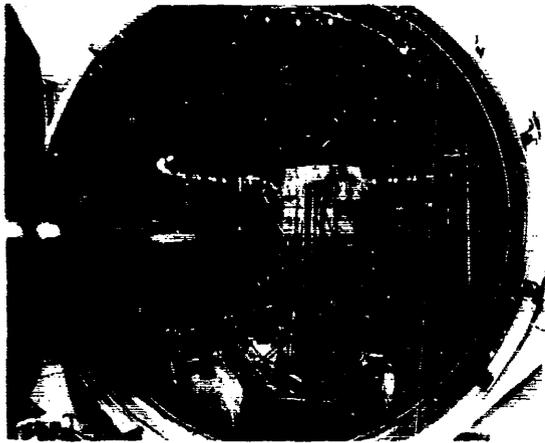
**AUGUST 11:** An in-residence Orbital Workshop task team was established at MDAC-W (McDonnell Douglas Astronautics Company-Western Division) by MSFC. The team's purpose was to provide timely programmatic and technical interface with and response to the contractor in matters relating to hardware design, development, qualification, manufacturing and checkout. W.K. Simmons, Jr., MSFC Orbital Workshop Project Manager, was appointed leader of the team whose members represented the various MSFC technical disciplines. Due to the significant number of MSC operational and hardware interfaces with the Workshop, MSC assigned James Shows and Richard Truly as members of the team [201].

**SEPTEMBER 8:** The ATM Prototype was delivered to MSC aboard the Super Guppy aircraft. At MSC, the prototype was scheduled for extensive thermal vacuum chamber testing [202].



**ATM PROTOTYPE IN CHECKOUT AT MSFC  
PRIOR TO SHIPMENT TO MSC**

September -- October 1971

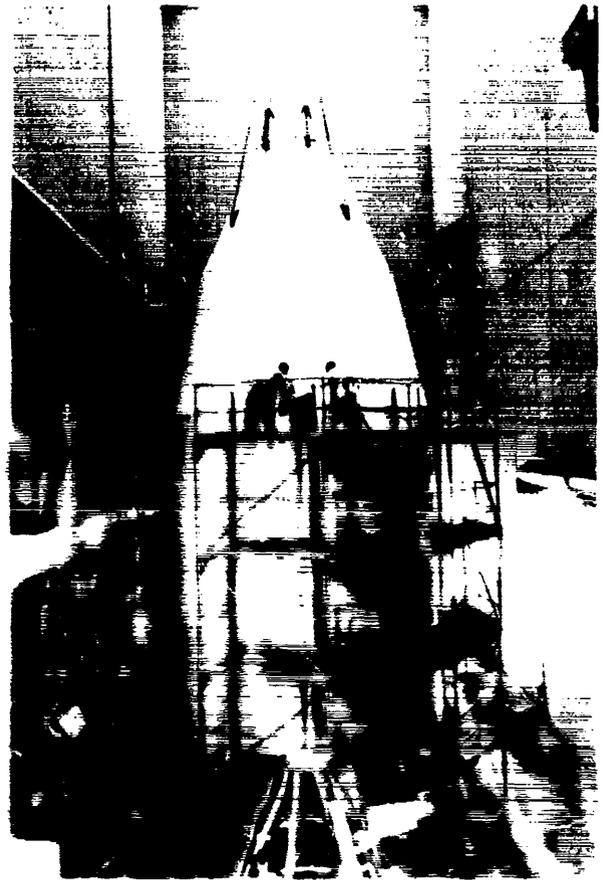


**ATM PROTOTYPE IN THE THERMAL VACUUM CHAMBER AT MSC**

**SEPTEMBER 15:** The MDA Crew Compartment Stowage Review was held September 13-15, 1971, at MMC Denver, utilizing the one-g trainer. Eight crewmen participated, including newly promoted Admiral Alan Shepard of Apollo 14 fame [203].

**SEPTEMBER 23:** One of the primary concerns of the Skylab program was one of weight control. A weight control limit of 196 000 pounds was established in order to maintain vehicle attitude control. To insure program visibility of the weight growth situation, a series of monthly telecon meetings was initiated in December 1970 with the Skylab Program Office, MSC, and MSFC participating. As a result, reasonable control weights were established, weight reporting procedures were streamlined, and the maturity of weight data significantly improved [204].

**SEPTEMBER 24:** NASA accepted the Skylab payload shroud (nosecone) from the McDonnell Douglas Astronautics Company. This shroud, 60 feet long with a 22-foot diameter, weighed almost 26,000 pounds and was the first major piece of Skylab hardware to be delivered to NASA [205].



**PAYLOAD SHROUD FLIGHT UNIT IN FINAL ASSEMBLY AT MDAC-WD**

**OCTOBER 1:** The AM Crew Compartment Stowage Review was held from September 29 to October 1, 1971, at the McDonnell Douglas facility at St. Louis, Missouri. Several crewmen attended this review [206].

**OCTOBER 4:** The Manned Space Flight Experiment Board approved the following changes to the list of corollary experiments for the Skylab Program. The following experiments were added [207]:

- M516 Crew Activities/Maintenance
- M551 Metals Melting
- M552 Exothermic Brazing

October 1971

M553 Sphere Forming

M554 Composite Casting

M555 GaAs Crystal Growth

Earth Terrain Camera

**OCTOBER 8:** The MDA one-g trainer arrived at MSC. Installation began immediately for use in the astronaut crew training [208].



**SKYLAB/MDA NASA TRAINER – INTERIOR VIEW**

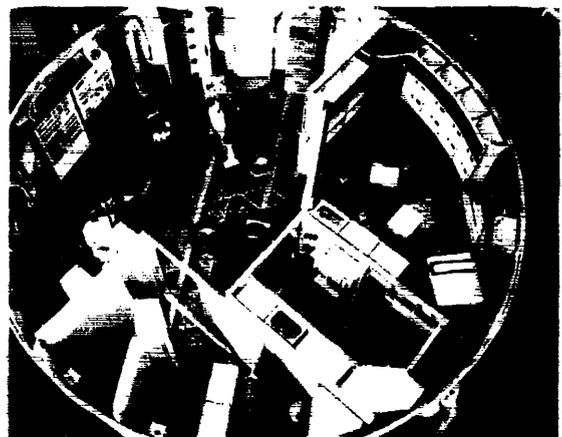
**OCTOBER 11:** Training mockups of two Skylab spacecraft components (the Orbital Workshop and Apollo Telescope Mount) arrived at MSC aboard the NASA barge Orion from MSFC. The shipment also included the multiple docking adapter exterior shell and portion of the airlock module mockup. Trainers and hardware would be used by MSC for training prospective Skylab crewmen for missions scheduled to begin in early 1973 [209].

**OCTOBER 15:** NASA announced that Skylab astronauts would begin extravehicular training in pressurized suits in the MSFC Neutral Buoyancy Space Simulator later in 1971. Mockups of the Skylab space laboratory modules had been submerged in a water tank

of 40 feet deep and 75 feet wide, which simulated the weightlessness of space environment [210].



**ATM 1-G TRAINER LOADING ON BARGE AT MSFC FOR SHIPMENT TO MSC**



**WORKSHOP 1-G TRAINER DELIVERED TO MSC FROM MSFC (CREW QUARTERS VIEW)**

**OCTOBER 18:** The AM one-g trainer arrived at MSC on a contingent of six trucks, the first arriving on October 14 and the last arriving October 18, 1971 [211].

## October – November 1971

**OCTOBER 19:** The Saturn IB first stage for the first manned Skylab launch vehicle was removed from the environmentally controlled enclosure at Michoud Assembly Facility after a 3-year hibernation. This booster, one of nine IB stages stored there in December 1968, would begin a 10-month refurbishment program in preparation for Spring of 1973 launch [212].

**NOVEMBER 2:** Dr. Fletcher, NASA Administrator, approved the Skylab Student Project, a joint effort between NASA and the National Science Teachers Association to stimulate interest in science and technology by directly involving students in space research. In this project, experiments proposed by students would be conducted by the astronauts on board Skylab in the course of the three planned missions. MSFC was directed by the Skylab Program Director to perform the development and integration efforts and to be the NASA interface with the students. Upon selection, MSFC would design and fabricate the experiments [213].

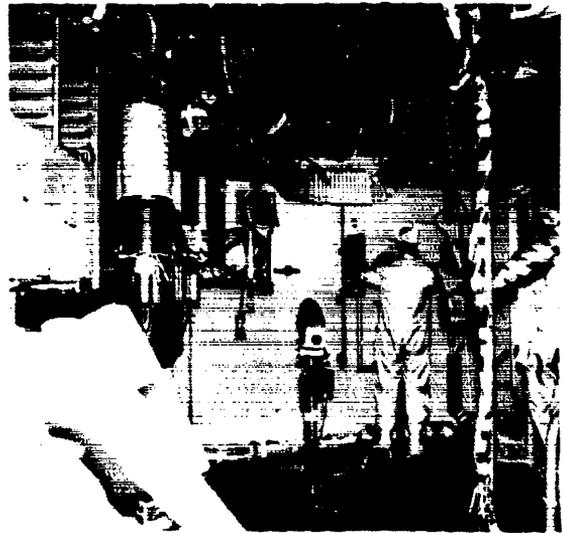
**NOVEMBER 11:** NASA added an astronaut shower into the Workshop crew quarters [214].

**NOVEMBER 15:** In a letter to Dr. Rees, MSFC Center Director, Mr. Dale Myers, Associate Administrator for Manned Space Flight, announced the formation of an MSF Task Team to conduct a "Mid-Term" Review of the Skylab Program. The stated objectives were to assess the validity of the Skylab Program Plan in terms of scope of work planned and its relation to schedules and resources, to validate the run-out cost with a new and bottoms-up estimate of resources required to completion, and to make management and technical recommendations as required. The Task Team was scheduled to complete its work before Christmas of 1971 with a report to the Management Council at the January meeting [215].

**NOVEMBER 17:** MSFC announced that Skylab flight hardware manufacturing was nearing completion. Post-manufacturing checkout would soon begin at industrial and Government installations. Major Skylab spacecraft components as of the date of this announcement included the Workshop, Apollo Telescope Mount solar observatory, airlock module, and the multiple docking adapter [216].

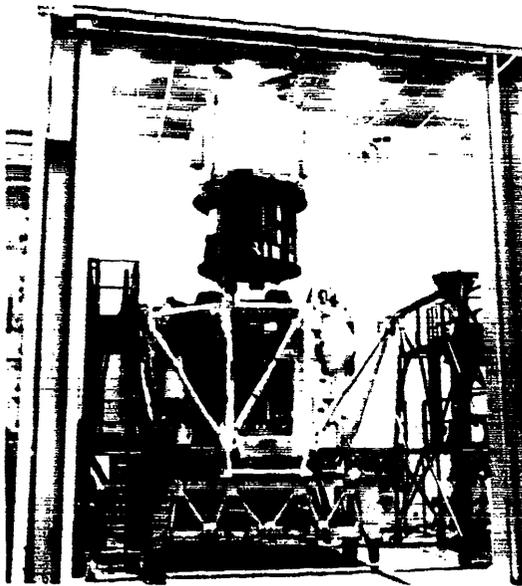


**ASTRONAUT SHOWER WORKSHOP  
MOCKUP**

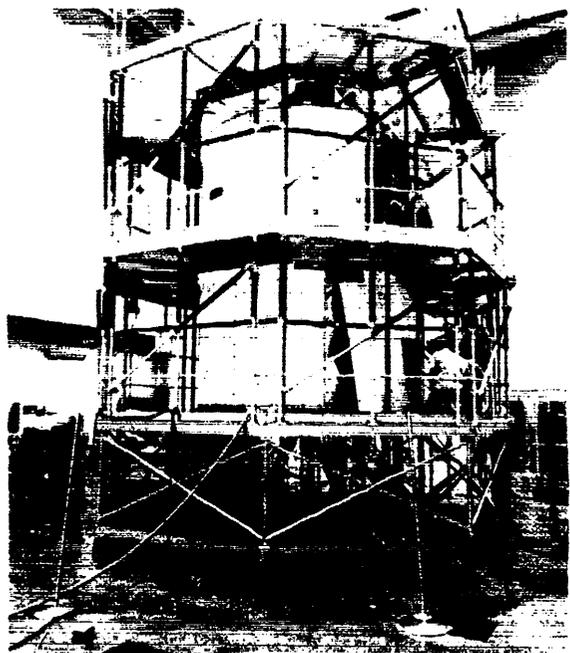


**INSTALLATION INTO WORKSHOP FLIGHT  
UNIT PRIOR TO START OF CHECKOUT**

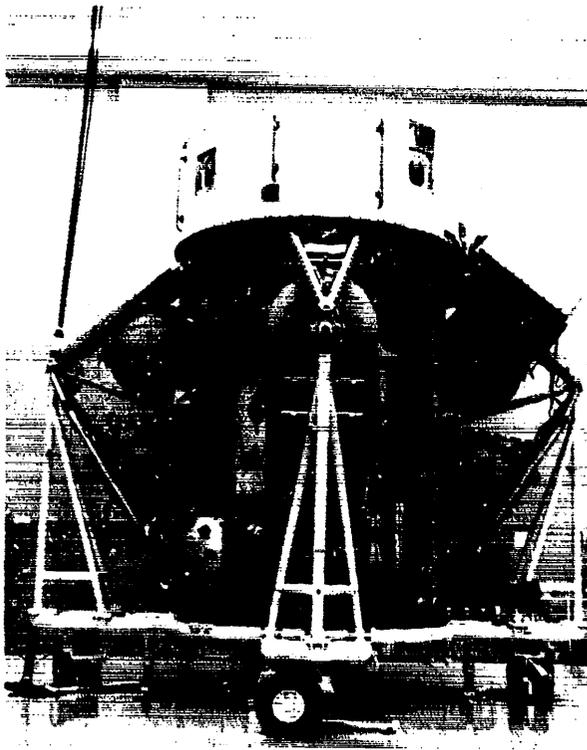
November 1971



**FINAL ASSEMBLY OF ATM FLIGHT UNIT**



**FINAL ASSEMBLY OF MDA FLIGHT UNIT**



**FINAL ASSEMBLY OF AIRLOCK MODULE  
FLIGHT UNIT**

**NOVEMBER 26:** MSFC awarded the Chrysler Corporation's Space Division a contract modification for additional work on Saturn IB launch vehicle booster stages. The contract extension was valued at 5,804,216 dollars, and the work would run through January 31, 1974. The additional work involved refurbishment of four S-IB booster stages that would be used in the Skylab Program in 1973. The fourth vehicle (SA-209) would be assigned to Skylab as a backup. All four stages had been in storage for several years and would have to be refurbished. The major portion of the work would involve the removing of these stages from storage, preparing them for delivery to KSC, and providing launch support to them throughout the Skylab launch readiness period, which would end in early 1974. Most of the work would be done at Michoud in New Orleans, and some work would be done at Huntsville [217].

**NOVEMBER 29:** MSFC amended a contract with the General Electric Company for support

## November – December 1971

of the Saturn Program to allow modifications in support of the Skylab Program. The contract change was valued at 1,967,894 dollars and would be completed by April 1, 1972. The basic contract was for engineering and logistics support by General Electric of Saturn launch vehicle ground support equipment at KSC and for operations of a systems development facility (a "breadboard" simulator) at MSFC and was scheduled to be completed by December 31, 1973. The new work detailed the manufacture and delivery of modification kits for the reconfiguration of ground support equipment at KSC's Launch Complex 39 to provide a Saturn IB launch capability to support Skylab [218].

**NOVEMBER 30:** Dr. Rees was so impressed by a speech that NASA Administrator Dr. Fletcher made before the National Space Club in Washington on November 18, 1971, that he sent the following memorandum to all key MSFC officials: "Your attention is invited to the enclosure, an address by Dr. Fletcher to the National Space Club. This address entitled, 'The NASA Space Program Today – and Tomorrow,' is an excellent work, dealing clearly and concisely with matters pertaining to the Shuttle. In defining the current status and in announcing plans for the future, the document stabilizes the NASA course in clear and unmistakable terms. The address is of great interest and value to everyone at Marshall. Accordingly, I ask that you give it the widest possible distribution within your office or directorate."

In the address cited by Dr. Rees in his memorandum, one of the points made by Dr. Fletcher was that in the immediate future, NASA's space efforts should center in space around the earth, and that with programs such as Skylab and the Space Shuttle, NASA would have an ideal opportunity to bring space dividends back to earth [219].

**DECEMBER 9:** The MDA Crew Compartment Fit and Function Test was held at MMC December 7-9, 1971. Skylab crewmen participated [220].

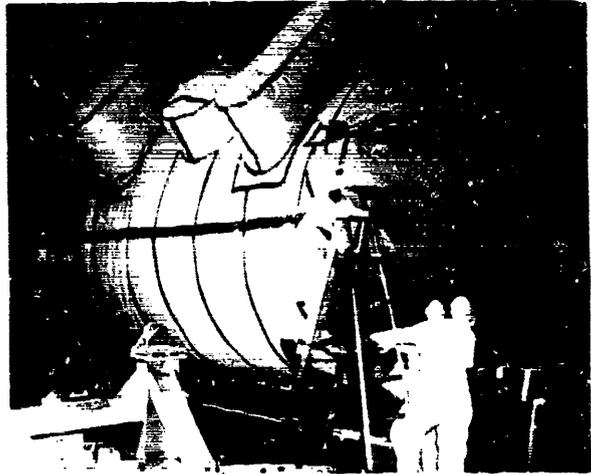
**DECEMBER 13:** The Manned Space Flight Experiment Board approved the following changes to the list of corollary experiments for the Skylab Program. Experiment T018 (Precision Optical Tracking) was deleted [221].

**DECEMBER 15:** The prototype of the Skylab Apollo Telescope Mount (ATM) came back to MSFC from MSC. The ATM prototype arrived aboard the Super Guppy aircraft. At MSFC, the ATM was placed in a clean room in the Quality and Reliability Assurance Laboratory, where it would undergo systems checkout. Following the Quality Laboratory checkout, the prototype would undergo vibration testing in the Astronautics Laboratory, and then would be refurbished and serve as a backup for the flight model. While at MSC, the ATM prototype, which was assembled at MSFC, was subjected to space conditions in a large chamber used for testing the Apollo spacecraft [222].

**DECEMBER 15:** An inter-Center agreement was approved between the Manned Spacecraft Center and Marshall Space Flight Center detailing the responsibilities of the two Centers for Skylab flight crew training in the Neutral Buoyancy Simulator at MSFC. The agreement was approved by Kenneth S. Kleinknecht for the Manned Spacecraft Center and by Leland F. Belew for the Marshall Space Flight Center [223].

December 1971

**DECEMBER 17:** MSFC announced that it had accepted the flight multiple docking adapter for Skylab at the Martin Marietta Corporation facility in Denver, Colorado. Five days later, the flight MDA went from Denver to the McDonnell Douglas Astronautics Company facility in St. Louis, Missouri, aboard the Super Guppy aircraft [224].



**PREPARATION OF MDA FLIGHT UNIT FOR SHIPMENT TO MDAC-ED**

1972

1972

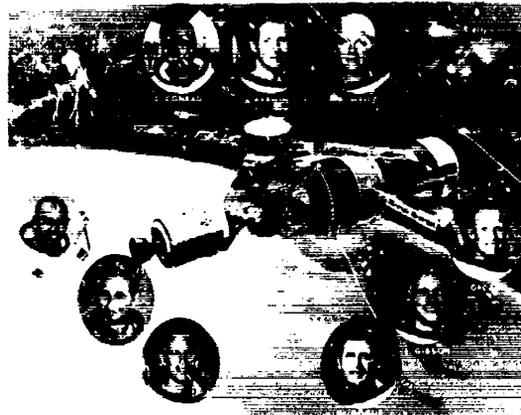
**JANUARY 11:** During the MSF management council meeting held on January 11-12, two of the major council agreements were: to retain the currently planned Skylab launch readiness date of April 30, 1973; and to assign no more experiment or other effort requiring changes to hardware, flight plans, or training [225].

**JANUARY 18:** Approval was given by Headquarters for the addition of a video tape recorder to the Skylab TV System, after a presentation on the subject to Mr. Myers and Mr. Schneider at MSFC. The addition of the recorder will provide increased flexibility and the capability for more TV coverage. Playback of the recorder will be controlled by the ground [226].

**JANUARY 18:** MSFC assigned Wayne Patterson as the AM/MDA integrated test manager on site at MDAC-E with additional MSFC personnel representing various technical disciplines as required and resident office personnel to support the AM/MDA flight hardware integrated testing. He was responsible for coordination of all interfaces between MSC, MSFC KSC, MMC, and MDAC-E relative to the tests. This included scheduling of all planned and unplanned manufacturing, retrofit, modification, and repair on the Airlock and MDA [227].

**JANUARY 18:** NASA announced the names of the Skylab astronaut prime and backup crews. For Skylab Mission 1, astronauts named were Charles Conrad, Jr., Joseph Kerwin, and Paul Weitz, for Mission 2, astronauts named were Alan Bean, Owen Garriott, and Jack Lousma, and for Mission 3, astronauts named were Gerald Carr, Edward Gibson, and William Pogue. Backup astronauts for Mission 1 would be Russell Schweickart, Story Musgrave, and Bruce McCandless; backup astronauts for Missions 2 and 3 would be Vance Brand, William Lenoir, and Don Lind [228].

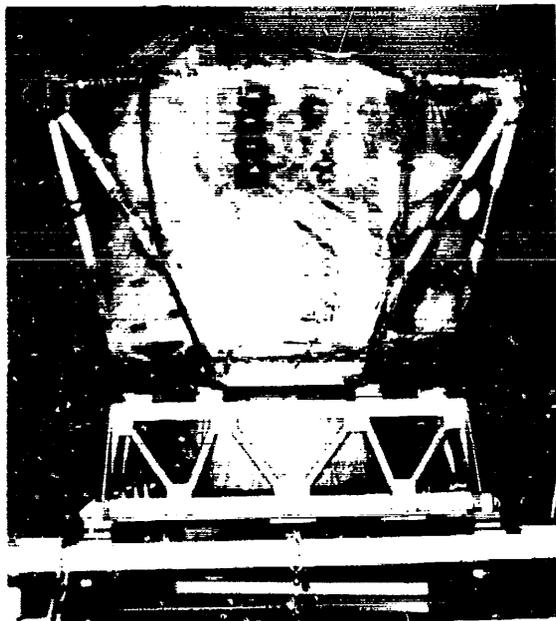
**JANUARY 19:** Skylab crew press conference, with prime and backup crewmen, was held at MSC. Astronaut Charles Conrad, Jr., said preparations were on schedule for April 1973 launch. Contractor checkouts and tests of hardware were expected to be completed for delivery to KSC in July. Skylab would carry some 20,000 pieces of stowage equipment on board to provide life support for 9 men for 140 days. "All goes up at one time, and we've got a great deal of work to do, not only to learn how to operate this vehicle but also all the experiments in it. It became apparent that we could not be 100 percent cross-trained as we had been in Apollo, so we've...defined some areas for each guy to become expert in... That allowed us to balance out the training hours. Right now...we have some 2000 training hours per man defined. We've been working on the basic training for the past year...[and] our training hardware...[is] going to be available to us for training...about February 1." Commander would have overall responsibility for mission and would be CSM expert. Science pilot would be expert in all medical equipment and in ATM and its associated hardware. Pilot would be expert in Orbital Workshop systems and electrical systems. Remaining experiments would be divided among crew members according to availability and choice [229].



**SKYLAB PRIME CREWS**

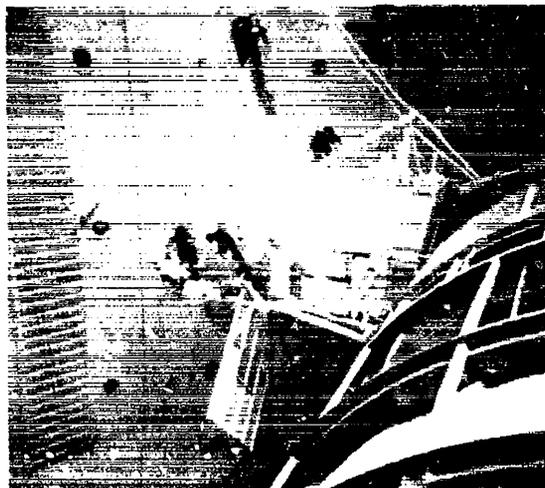
## January – February 1972

**JANUARY 28:** The ATM flight unit was delivered to the Quality Laboratory to begin post-manufacturing checkout [230].

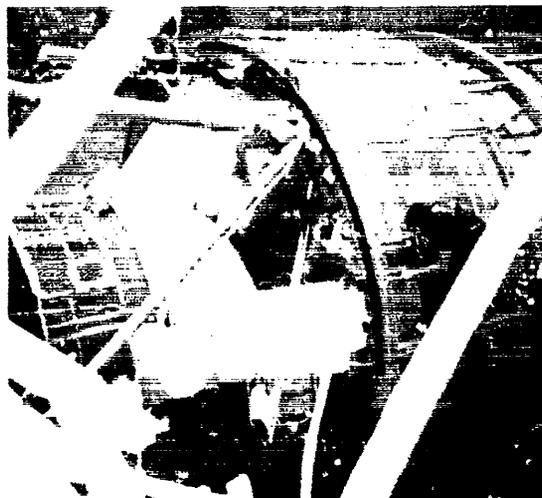


**ATM FLIGHT UNIT IN QUAL LAB PRIOR TO ENTERING CHECKOUT STATION**

**FEBRUARY 9:** Formal astronaut crew training began in neutral buoyancy at MSFC. Astronauts Pete Conrad, Joseph Kerwin, Rusty Schweickart, and Story Musgrave performed EVA exercises in the neutral buoyancy tank [231].



**ASTRONAUT MUSGRAVE AT ATM SUN END WORK STATION**



**ASTRONAUT SCHWEICKART AT FAS WORK STATION DEPLOYING BOOM WITH FILM MAGAZINE ATTACHED**

February 1972

**FEBRUARY 11:** NASA awarded a contract modification to the Martin Marietta Corporation to cover additional work relative to Skylab Program Payload Integration, the multiple docking adapter, and the ATM C&D console. This modification required the contractor to provide additional ground support equipment for horizontal checkout of the MDA [232].

**FEBRUARY 18:** Vibration testing began on the ATM prototype at MSFC. After vibration testing, the prototype was scheduled for disassembly and refurbishment to become the backup ATM flight unit [233].



**ATM PROTOTYPE ON SHAKER TABLE  
IN PREPARATION FOR VIBRATION TEST**

**FEBRUARY 22:** Skylab Program Director William C. Schneider outlined the program's progress: "Manufacture is largely complete, test and checkout are progressing satisfactorily, delivery of certain components has occurred

with delivery of the remainder in sight, and operating of Skylab in orbit will begin before the end of the coming Fiscal Year."

Skylab offered "an Earth observation capability never before available" to U.S. manned spacecraft. During an 8-month mission, Skylab would fly over entire U.S. except Alaska, over much of Europe, all of Africa, Australia, China, and almost all of South America — covering 75 percent of earth's surface and passing over each point every five days. By the end of 1971, 388 investigations requiring Skylab data had been submitted, 249 U.S. and 39 foreign. Of these, 164 had been identified for further study. Skylab was "first manned space flight program designed specifically to carry activities and equipment explicitly aimed at improving man's life on earth. It will contribute significantly to the increase of knowledge of pure science and is also a primitive space station, a forerunner of permanent space stations of the future." Earth-oriented sensors would test technology for synoptic surveys of many environmental and ecological factors and give preliminary data for management of ecological systems. Solar and astronomical observations and other science experiments would expand knowledge of solar system, universe, and near-earth space. Biomedical experiments would inform how man's well-being and ability to function were affected by living in space [234].

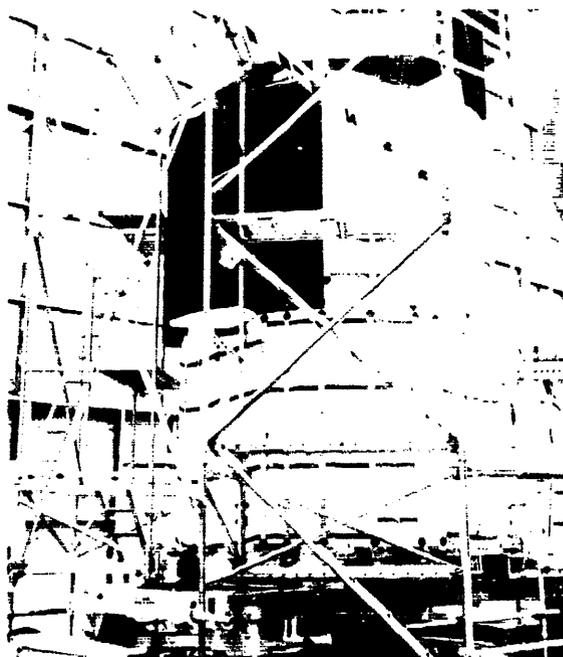
**FEBRUARY 24:** Deployment tests of Skylab Workshop meteoroid shield were underway at Marshall Space Flight Center. The meteoroid shield, a thin sheet of aluminum wrapped around outer wall, would protect Skylab crewmen from micrometeoroids and ensure comfortable temperature in space [235].

**FEBRUARY 28:** A review of the Skylab program was made in December 1972 by a Skylab program midterm task team. Among the findings of the task team were: Although there is little margin left in the schedule for contingencies, there were no known reasons why the launch date of April 30, 1973, could not be met; planned resources were sufficient

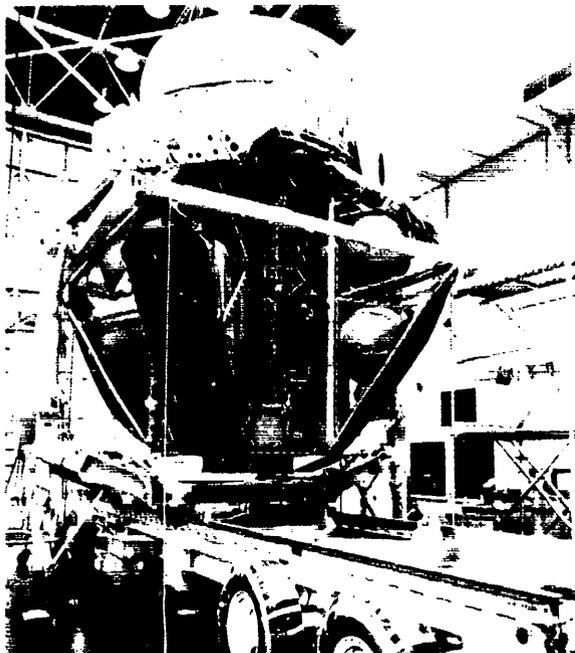
## February – March 1972

to support the program on the established schedule; a comprehensive and systematic program of reviews, tests, and analyses were performed to produce high confidence in technical performance with reliability and safety; a greater number of formal detailed program level plans and inter-center agreements were required in Skylab than in earlier programs because of complexities of technical organizational interfaces; limitations on travel funds created problems; there was some concern regarding the EREP where costs exceeded the original plan; technical problems remained; and PI's had not been selected [236].

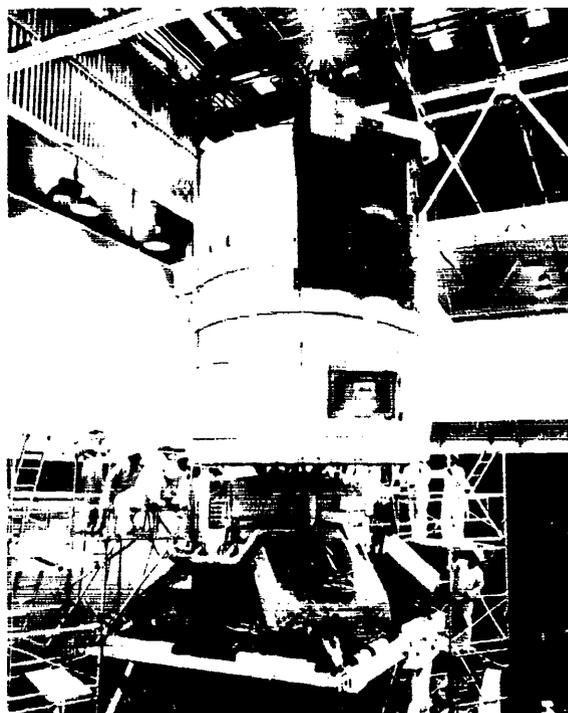
**MARCH 5:** The airlock and MDA flight units were hardmated at MDAC-ED. These units would remain mated through checkout, delivery to KSC, launch, and throughout the mission [237].



**MDA FLIGHT UNIT AT MDAC-ED PRIOR TO MATING WITH THE AIRLOCK FLIGHT UNIT**



**AIRLOCK MODULE FLIGHT UNIT PRIOR TO MATING WITH MDA FLIGHT UNIT**



**MATING OF AIRLOCK AND MDA FLIGHT UNITS AT MDAC-ED**

March – May 1972

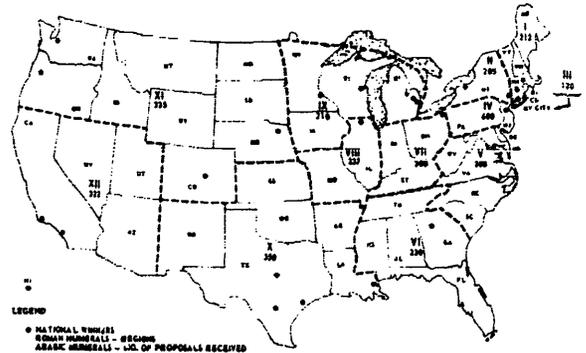
**MARCH 27:** More than 87,946 application forms for participation in the Skylab Student Project had been requested of the National Science Teachers Association, which was managing the activity for NASA. NASA estimated that approximately 50,000 applicants were requesting these forms. From this number, NASA received 3409 proposals. The Skylab Student Project was designed to stimulate interest in science and technology by directly involving U.S. school students in grades 9 through 12. Entries consisted of proposals by students of groups of students for experiments, demonstrations, or activities to be performed by astronauts during Skylab missions in 1973 [238].

**APRIL 3:** The first major delivery of Skylab ground support equipment to KSC was accomplished when the Saturn Workshop integration electrical support equipment arrived [239].



**DELIVERY OF SWS ELECTRICAL SUPPORT EQUIPMENT TO KSC**

**APRIL 6:** NASA announced the 25 national winners in the Skylab Student Experiment Project [240].



### **SKYLAB STUDENT EXPERIMENT PROJECT LOCATION OF 25 NATIONAL WINNERS**

**APRIL 30:** MSFC announced that it had designed and built a compact shower assembly for use on Skylab earth-orbital missions beginning in 1973. The shower would remain stored on the floor when not in use. Astronauts would step inside the ring on the floor and raise fireproof beta cloth curtain on a hoop and attach it to the ceiling. The flexible hose with a push-button shower nozzle could spray 2.8 liters (3 quarts) of water from a personal hygiene tank during each bath. Used water would be vacuumed from shower enclosure into a disposable bag and deposited in the waste tank [241].

**MAY 1:** MSFC announced completion of the largest solar-cell-array system for electric power ever devised for spacecraft. Two arrays, with almost 236 square meters (2540 square feet) of surface area, would use sunlight to power electrical systems of Orbital Workshop, Apollo Telescope Mount, and other major components of Skylab cluster scheduled for launch in 1973. Each array could provide 10 500 watts of power – more than twice average level needed for three-bedroom house – at 328°K (130°F) during 58- to 69-minute portion of each 94-minute orbit [242].

**MAY 8:** NASA officials met with 25 national winners in the Skylab Student project competition at Marshall Space Flight Center to

## May 1971

discuss design of student's space experiments and demonstrations. During the visit students toured MSFC laboratories and Alabama Space and Rocket Center [243].

**MAY 11:** The ATM Crew Compartment Fit and Function ( $C^2F^2$ ) was conducted at MSFC. Skylab astronauts participated in this review in which ATM flight cameras and film cassettes were checked against their mission interfaces. [244].

**MAY 17:** Skylab Orbital Configuration Vibration Modal Survey test requirements, facility overview, automatic modal tuning and analysis system status, test article status, data processing and handling, shaker installation, and miscellaneous items were reviewed by the test readiness board at MSC. It was concluded that all mandatory test preparations and plans were complete and the test could proceed as scheduled [245].

**MAY 19:** Skylab statistics were released by NASA. Spacecraft, to be launched by two-stage Saturn V rocket in spring 1973, would contain 370 cubic meters (13 000 cubic feet) of working and living space. More than 13 000 individual items weighing a total of 5000 kilograms (11 000 pounds) for long-duration space mission would be stowed, including 910 kilograms (2000 pounds) of food, more than 2700 kilograms (6000 pounds) of water, 60 changes of astronaut jackets, shirts and trousers, 210 pairs of shorts, 30 constant-wear garments, 15 pairs of boots and gloves, 55 bars of soap, 96 kilograms (210 pounds) of towels, 1800 urine and fecal bags, 156 rolls of teleprint paper, 104 film magazines, medical kit, 108 pens and pencils, and vacuum cleaner [246].

**MAY 24:** President Richard Nixon and Premier Alexei N. Kosygin signed a 5-year agreement between the Government of the United States of America and the Government of the Union of Soviet Socialist Republics on cooperation in the fields of Science and Technology. The Space Agreement included the rendezvous and docking in earth orbit of an

American and a Soviet spacecraft and a coordinated effort to explore and share information on space. The agreement was formally signed May 24, 1972, in Moscow [247].



**NASA'S FIRST 1973 SKYLAB FLIGHT WAS ON THE HORIZON AS THE U.S. AND U.S.S.R. SIGN THEIR HISTORIC MAY 24, 1972, SPACE AGREEMENT IN MOSCOW**

**MAY 24-26:** The Workshop Crew Compartment Fit and Function Test ( $C^2F^2$ ) was conducted at MDAC-WD. Two astronaut crews participated in the review which consisted of reviewing the Workshop flight article and the approximately 8000 stowage items and their respective stowage locations [248].

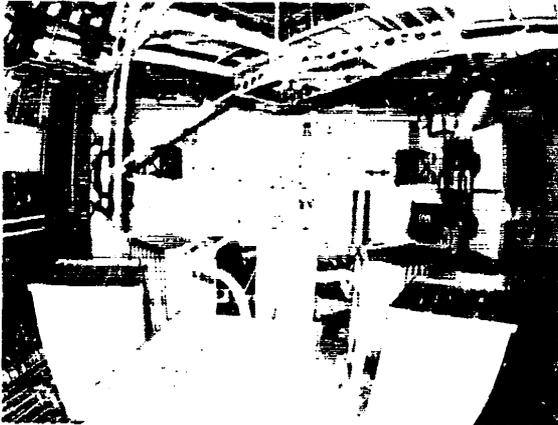


**WORKSHOP FLIGHT UNIT WORK AND EXPERIMENT AREA DURING  $C^2F^2$**

June 1972



WORKSHOP FLIGHT UNIT WARDROOM  
DURING C<sup>2</sup>F<sup>2</sup>



WORKSHOP FLIGHT UNIT FORWARD  
AREA DURING C<sup>2</sup>F<sup>2</sup>



POST-APOLLO MILESTONES OF THE 1970's

JUNE 2: The Manned Space Flight Experiment Board approved the following changes to the list of corollary experiments for the Skylab Program [249]. The following experiments were added:

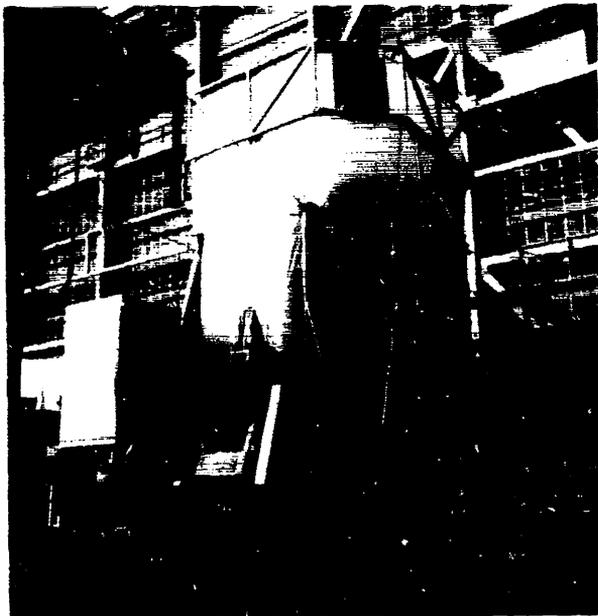
- S228 Trans-Uranic Cosmic Rays
- M518 Multipurpose Furnace System
- M556 Vapor Growth of II-VI Compounds
- M557 Immiscible Alloy Compositions
- M558 Radioactive Tracer Diffusion
- M559 Microsegregation in Germanium
- M560 Growth of Spherical Crystals
- M561 Whisker Reinforced Composites
- M562 Indium Antimonide Crystals
- M563 Mixed III-V Crystal Growth
- M564 Metal and Halide Eutetics
- M565 Silver Grids Melted in Space
- M566 Copper-Aluminum Eutetic

JUNE 2: The ATM flight unit successfully completed vibration acceptance testing at MSFC. The unit went through a modification period prior to shipment to MSC on June 23, 1972 [250].

JUNE 6: The AM/MDA Crew Compartment Fit and Function Test was completed at MDAC-E [251].

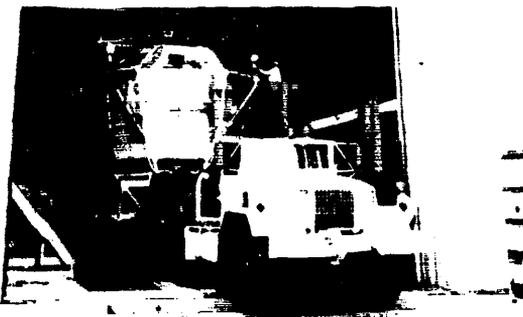
JUNE 23: The payload assembly vibroacoustic test was completed. The dynamic test hardware was then to be used for platform fit checks before destacking and shipment to MSFC on August 1, 1972 [252].

June - July 1972

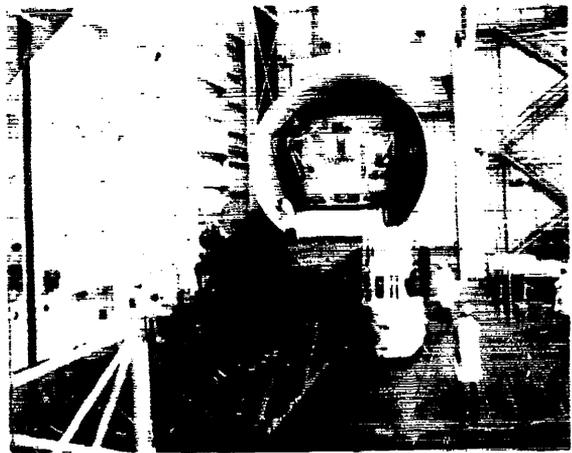


**ATM FLIGHT UNIT UNDERGOING VIBRATION TESTING IN PORTABLE CLEAN ROOM AT MSFC**

JUNE 23: The ATM flight unit was delivered to MSC by the Super Guppy aircraft for thermal vacuum testing. A configuration turnover review was conducted prior to delivery [253].



**ATM FLIGHT UNIT LEAVING QUALITY LABORATORY PRIOR TO DELIVERY TO MSC**



**ATM FLIGHT UNIT IN SHIPPING CONTAINER IN PREPARATION FOR DELIVERY TO MSC**

JULY 18: The Skylab menu, in addition to being the most palatable menu carried into space, was also designed to meet the requirements and objectives of an important series of medical investigations. There were a number of preflight, inflight, and postflight medical experiments which would be dependent on a detailed, quantitative knowledge of what each crew member consumed throughout his exposure to orbital flight. The food system for Skylab was designed to maintain a calorie level of between 2000 and 2800 calories. It was baselined to provide at least the minimum dietary allowances of protein, carbohydrate, fat, minerals, and vitamins recommended by the National Academy of Science. The menu included such items as tomato soup, scrambled eggs, turkey and gravy, prime rib of beef, lobster Newburg, desserts, and beverages [254].

JULY 26: The Skylab Medical Experiment Altitude Test (SMEAT), conducted by a test crew of three astronauts, began on July 26. Astronauts Robert Crippen, the crew commander; Dr. William Thornton, the science pilot; and Karol Bobko, the pilot, would spend

## July – September 1972

56 days in a 20-foot chamber designed to simulate the Skylab orbital workshop atmosphere. This ground-based simulation test was intended primarily for the purpose of obtaining and evaluating baseline medical data for 16 medical experiments scheduled for Skylab involving studies of the cardiovascular system, the expenditure of energy to do measured work, and food and nutritional investigations. The test crew was also engaging in a full schedule of activities involving work, eating, leisure, recreation, and sleep [255].

**AUGUST 3:** The AM/MDA altitude chamber test was completed in St. Louis with the flight crew participating in one ambient and one altitude run. The crew was at altitude for 8 hours and 4 minutes. Time was allowed for a 2-day run. However, it was not needed since the run went smoothly [256].

**AUGUST 22:** The Saturn IB first stage for the Skylab 2 arrived at the Kennedy Space Center aboard the NASA barge "Orion" and was immediately offloaded for processing in the Vehicle Assembly Building. Following preliminary checkout in the VAB transfer aisle, the S-IB-206 first stage will be erected atop the 39-meter (128-foot) tall pedestal on Mobile Launcher 1 on August 31. The stage arrival marked the first time in nearly four years that the 7168 kilonewton (1.6 million pound) thrust launch vehicle will have undergone flight preparation in the VAB. The Saturn IB was last launched by KSC from Launch Complex 34 on October 11, 1968, on the first manned mission of the Apollo lunar landing series – Apollo 7. That 11-day Earth orbital flight of Astronauts Walter M. Schirra, Donn F. Eisele, and Walter Cunningham proved the flightworthiness of the Apollo command/service module. A total of three Saturn IB's would be launched from Pad B of Launch Complex 39 during the Skylab program [257].

**AUGUST:** As the Skylab Program entered the operational phase, the Program Engineering and Integration Project, Skylab Program Office, MSFC, was reorganized and the

following personnel appointments were made by Leland F. Belew, Program Manager [258]:

George B. Hardy, Manager

Robert E. Pace, Deputy Manager, Operations

Carlos C. Hagood, Deputy Manager, Systems

Richard A. Marmann, Chief, Mission Engineering and Operations Integration Branch

Daniel M. Germany, Chief, Test, Engineering and Operations Integration Branch

Harry L. McDaris, Chief, Crew Systems Engineering and Operations Integration Branch

Leslie F. Adams, Chief, Integration Support Branch

Luther E. Powell, Chief, Electrical and Communications Systems Engineering and Integration Branch

John W. Thomas, Chief, Mechanical and Control Systems Engineering and Integration Branch

Carmine E. DeSanctis, Chief, Experiment Systems Engineering and Integration Branch

**SEPTEMBER 7:** The Skylab Program reached one of its final milestones with the completion of the Orbital Workshop, the main section of the Skylab Space Station. As of this date, the Workshop was ready for shipment to Cape Kennedy from the McDonnell-Douglas Astronautics Company, Huntington Beach, California. For the previous several days, NASA inspectors had been busy in California making last-minute inspection of the 9550-cubic-foot Workshop, in final

September 1972

configuration resembling that of a Saturn V moon rocket third state, which is 22 feet in diameter and 48 feet long. A special ceremony at McDonnell Douglas commemorated completion of this largest manned spacecraft component the U.S. had produced to date, a flying laboratory with a volume equivalent to that of a five-room house. NASA officials from Washington who attended the completion ceremonies included NASA Administrator Dr. James C. Fletcher, accompanied by Casper Weinburger, Director of the Office of Management and Budget. Other space agency officials present were William Schneider, Skylab Program Director in Washington, and Dr. Eberhard Rees, MSFC Director. Also attending from MSFC were Leland Belew, MSFC's Skylab Program Manager, and William Simmons, MSFC's Workshop Manager. Others attending the dedication were Kenneth S. Kleinknecht, Skylab Program Manager at Houston's Manned Spacecraft Center, Salter J. Kapryan, Director of Kennedy Launch Operations, and Robert C. Hock, Skylab Program Management at Kennedy Space Center. The following day, September 8, the Workshop would leave Seal Beach aboard the USNS Point Barrow. It would arrive at Kennedy Space Center 13 days later via the Panama Canal [259].

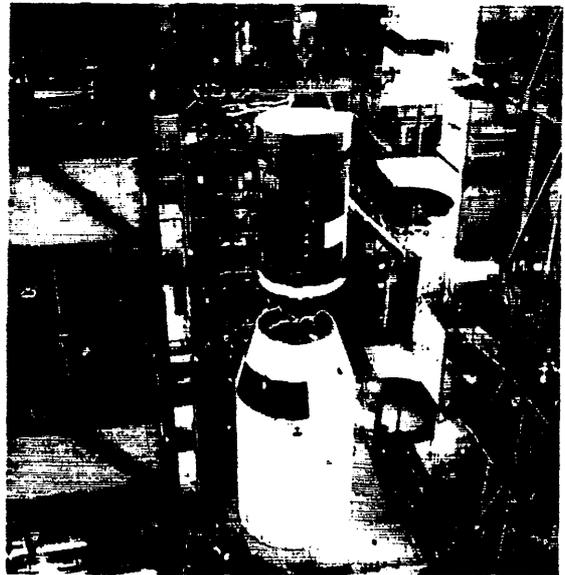


**WORKSHOP TURNOVER CEREMONY AT MDAC-W**

(Left to Right: W. Shapley, C. Weinberger, Dr. J. Fletcher, Dr. E. Rees, W. Burke, and D. Myers)



**TRANSFER OF OWS, PAYLOAD SHROUD, AND AFT INTERSTAGE FROM POINT BARROW TO KSC DOCK AT VAB**



**ERECTION OF OWS AND MATE TO S-II STAGE IN VAB**

SEPTEMBER 22: Following completion of the thermal-vacuum testing of the ATM flight unit at MSC, it was shipped to KSC aboard the Super Guppy aircraft [260].

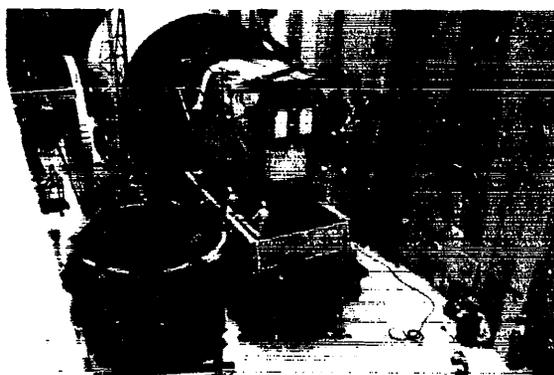
September – October 1972



**UNLOADING ATM FROM SUPER GUPPY  
AT KSC**



**UNLOADING AM/MDA FROM COMMERCIAL  
GUPPY AT KSC**

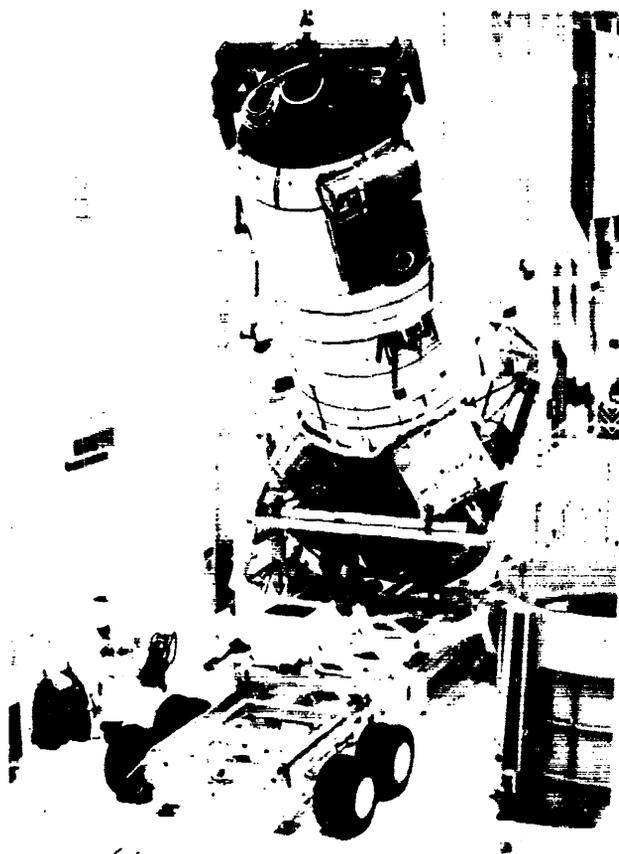


**REMOVING ATM FROM TRANSPORTATION  
CONTAINER IN O&C BLDG**

**SEPTEMBER 29:** The Workshop flight unit was stacked on the S-II-513 in the VAB and stack testing started [261].

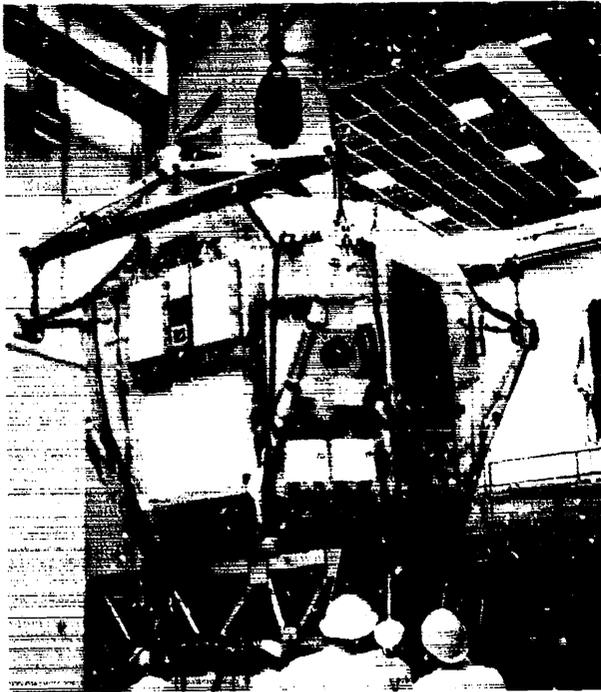
**OCTOBER 6:** The Airlock Module-Multiple Docking Adapter flight units reached KSC onboard the commercial Guppy from MDAC-E in St. Louis. This was the final major piece of Skylab hardware to be delivered to KSC in preparation for the April 30, 1973, launch [262].

**OCTOBER 11:** Following receipt, inspection, and installation into the class 10 000 clean room in the O&C building, the ATM flight unit checkout was started [263].



**REMOVING AM/MDA FROM  
TRANSPORTER IN O&C BLDG**

October 1972



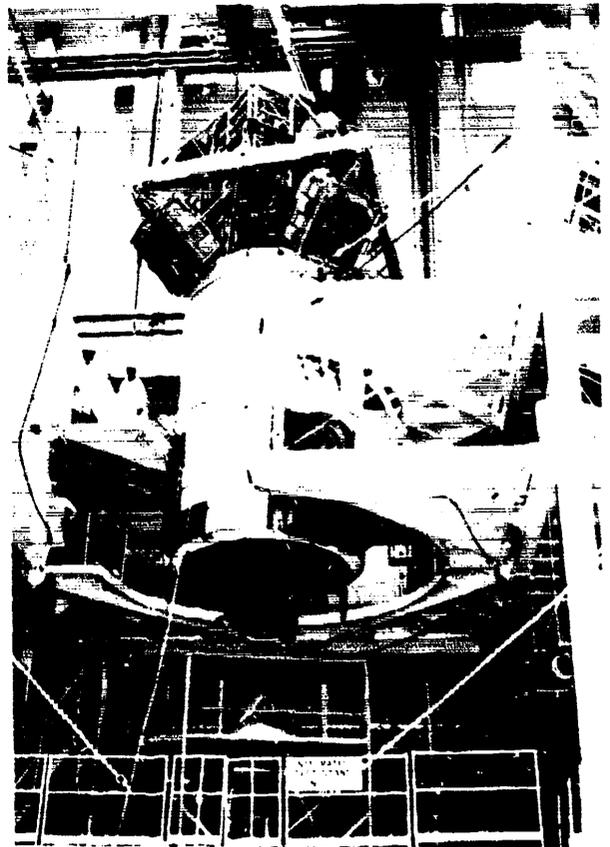
**INSTALLING ATM IN CLASS 10,000  
CLEAN ROOM IN O&C BLDG**

**OCTOBER 19:** The Skylab Cluster Systems Design Certification Review was conducted at MSFC. This review concluded the MSFC flight hardware and systems design certification effort which had started in early summer. All hardware was certified for flight subject to closing out identified open items [264].

**OCTOBER 21:** Following receipt, inspection, and installation into the O&C checkout station, integrated systems test and experiment test began on the AM/MDA flight units [265].

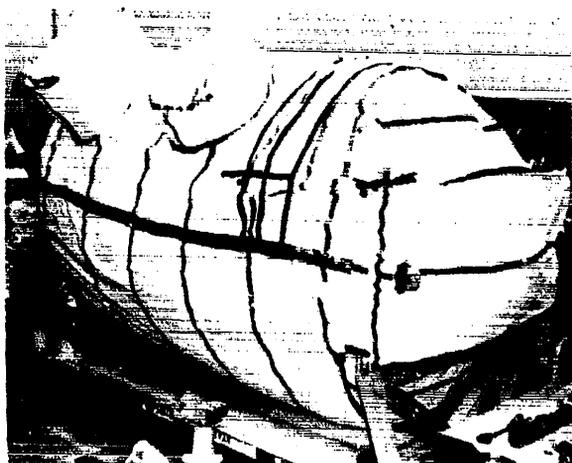
**OCTOBER 25:** The MDA backup flight unit was delivered to MDAC-E following the acceptance review at MMC, Denver. This unit

was to be mated with the Airlock backup flight unit and checked out to the point of being ready to support the Skylab 1, April 30, 1973, launch [266].

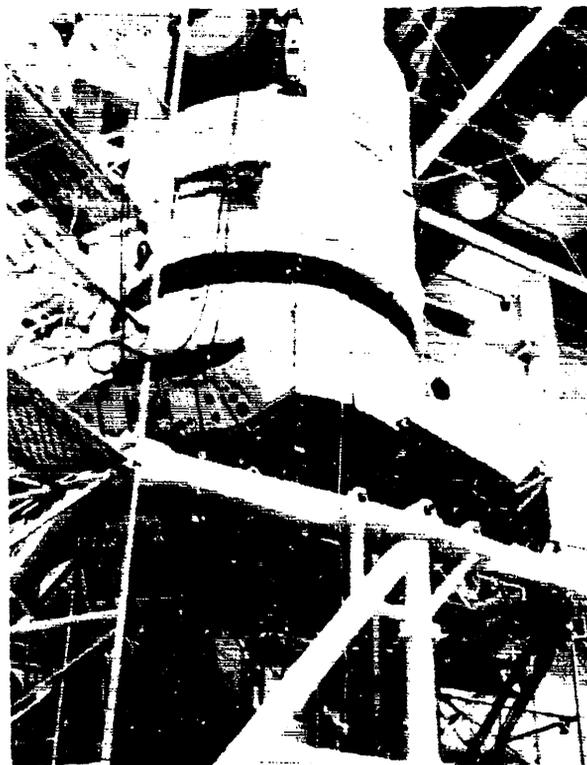


**DOCKING TEST OF AM/MDA TO CSM  
IN O&C BLDG**

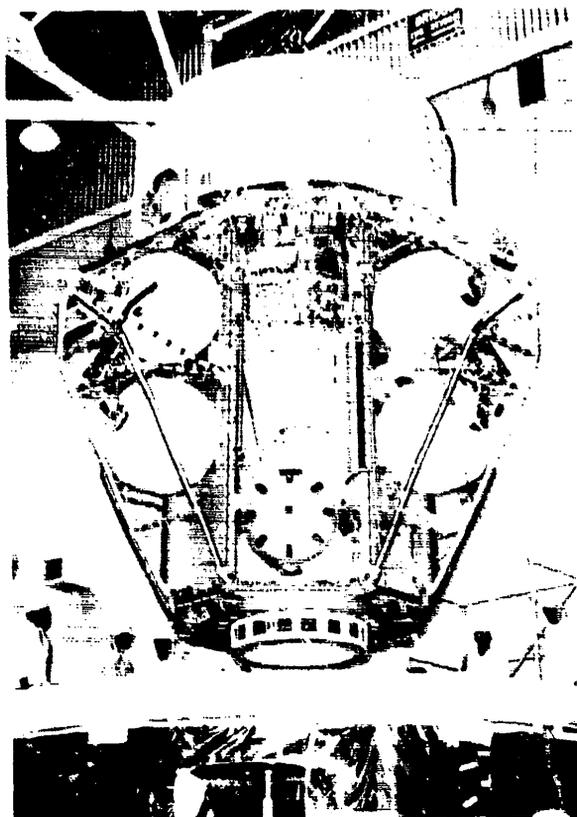
December 1972



**MDA BACKUP UNIT AT MMC PRIOR TO DELIVERY TO MDAC-E**



**MATING OF AM AND MDA BACKUP UNITS AT MDAC-E**



**AM BACKUP UNIT IN PREPARATION FOR MATING TO MDA**

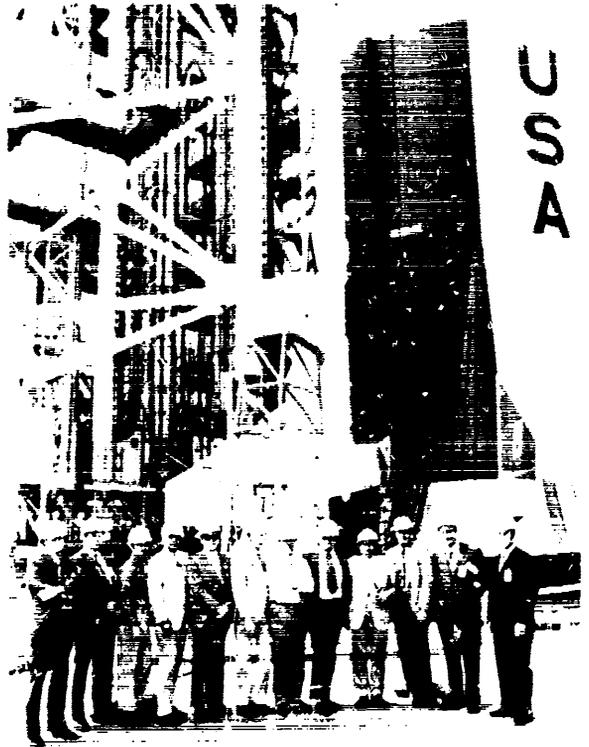
**DECEMBER 7:** The last Apollo Mission, Apollo 17, lift-off occurred at 12:33 a.m. EST. This was the first nighttime launch of an Apollo mission and the first to carry a professional geologist, Astronaut Harrison Schmitt. Commander was Eugene Cernan and Command Module Pilot was Astronaut Ronald Evans. Launch crews had been busy up to this time with three major missions, the Apollo 17, Skylab 1, and Skylab 2 scheduled for launch April 30 and May 1, 1973, respectively. For several months there had been concern about the capability to launch three major missions within this time frame, because it had not been done before [267].

**DECEMBER 15:** The last two ATM flight solar array wings went to KSC from MSFC by Super Guppy. The first two wings went on December 13. These wings were scheduled for

December 1972

installation on the ATM in mid-January 1973 [268].

**DECEMBER:** William Schneider, Skylab Program Director, and a group of Marshall Center officials, headed by Dr. Rees, reviewed the Skylab checkout activity at KSC in early December. In the group were Dr. Lucas, Hermann Weidner, James Shephard, Leland Belew, Jack Lee, Harry Johnstone, Erich Neubert, Ed Williams, and Richard Smith [269].



**NASA OFFICIALS BY SL-1  
LAUNCH VEHICLE**

1973

## January 1973

1973

**JANUARY:** ATM backup NRL-A experiment and H-Alpha No. 2 instrument were redelivered to MSFC for reassembly into the backup ATM. The remaining experiments were planned for delivery in January and February. The ATM backup unit was scheduled for reassembly and would be in a checkout mode by the Skylab 1 launch date [270].



**ATM BACKUP UNIT RACK  
INSTALLATIONS AT MSFC**

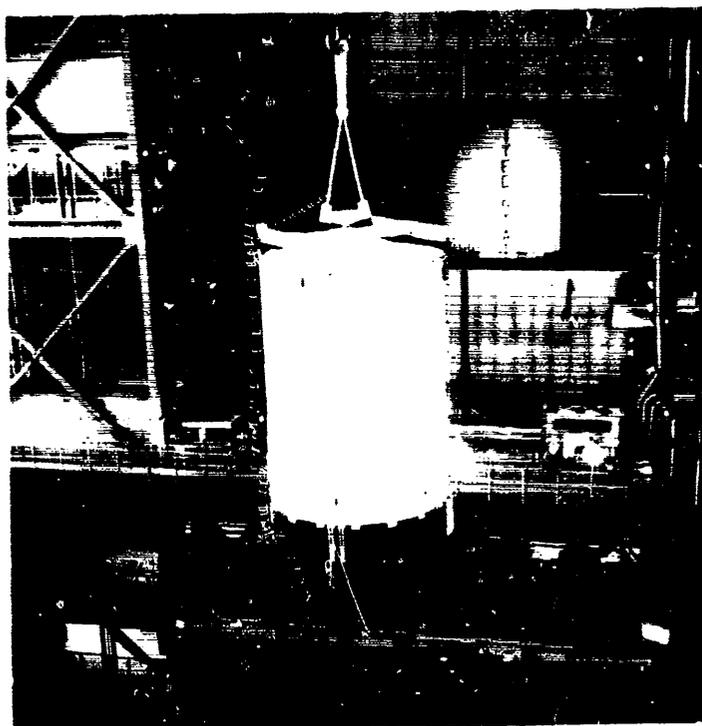


**THE THREE DIRECTORS OF THE  
MARSHALL CENTER**  
(From Left: Dr. Petrone, Dr. Rees and Dr. Von Braun)

**JANUARY 22:** An ATM Calibration Rocket (CALROC) all-up systems launch was accomplished at White Sands. This was one of a series of launches to qualify the CALROC program prior to the Skylab mission [271].

**JANUARY 26:** Dr. Eberhard Rees retired as Marshall Center Director, having served in that capacity since March 1, 1970. Dr. Rocco A. Petrone, Apollo Program Director, became the new Center Director [272].

**JANUARY 29 & 30:** A major milestone was accomplished when the Airlock Module/MDA and ATM flight units checkout was completed in the O&C building and they were transferred to the VAB. The Airlock/MDA were mated to the launch vehicle on January 29 and the ATM was mated January 30 [273].



**STACKING OF AM/MDA ON  
SATURN V-513**

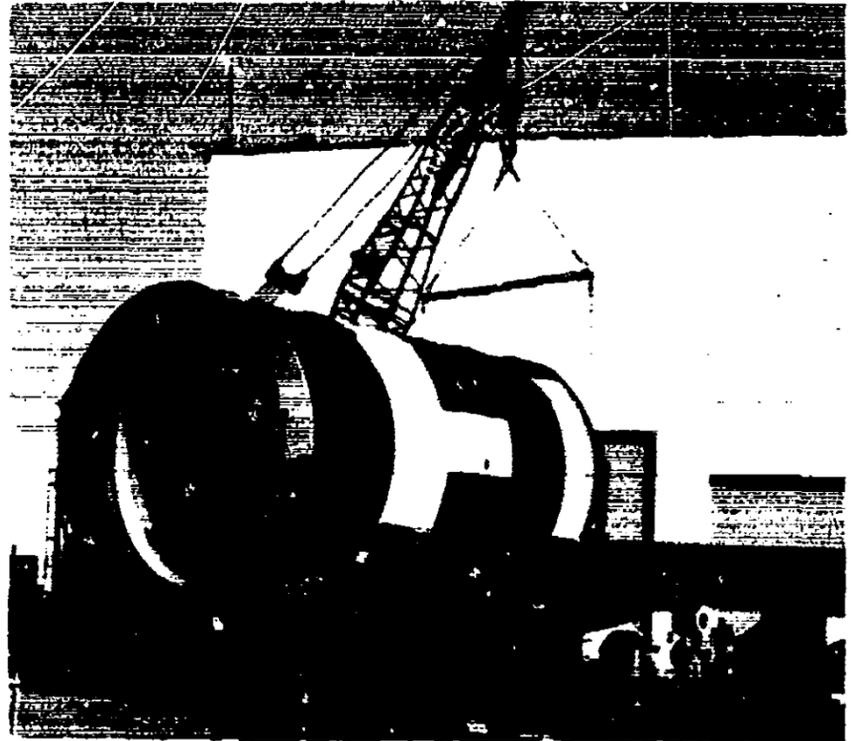
February 1973

**FEBRUARY 14:** At the February Management Council Meeting it was decided that the SL-1 and SL-2 launches would not be able to meet the April 30 and May 1 launch dates due to delays caused by unexpected checkout activities involving the modules at KSC. Tentative launch dates were set for May 14 and 15, respectively [274].



**ATM STACKING AT KSC**

**FEBRUARY 20:** The OWS high fidelity mockup arrived at MSFC from MDAC-W. It was updated for use as a systems engineering mockup along with AM/MDA and ATM dynamic test articles which were modified at MSFC for this use [275].



**WORKSHOP HI-FI MOCKUP ARRIVAL  
AT MSFC**



**MATING ATM TO LAUNCH VEHICLE  
STACK**

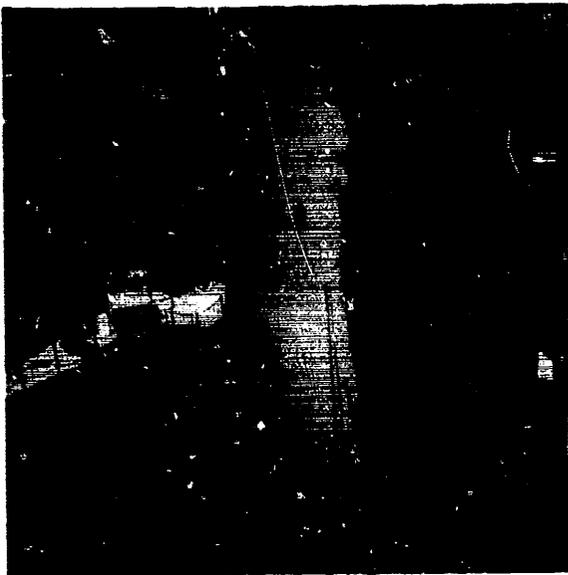
**FEBRUARY:** Flight Readiness Reviews (FRR) were conducted on all the Skylab modules in preparation for the MSFC Center Pre-FRR scheduled for early April 1973. The total SL-1 and 2 FRR were planned for mid-April [276].

**FEBRUARY 26:** The SL-2 Saturn IB vehicle was moved to the LC 39B from the VAB. The vehicle would remain on the pad undergoing final launch checkout activities until launch [277].

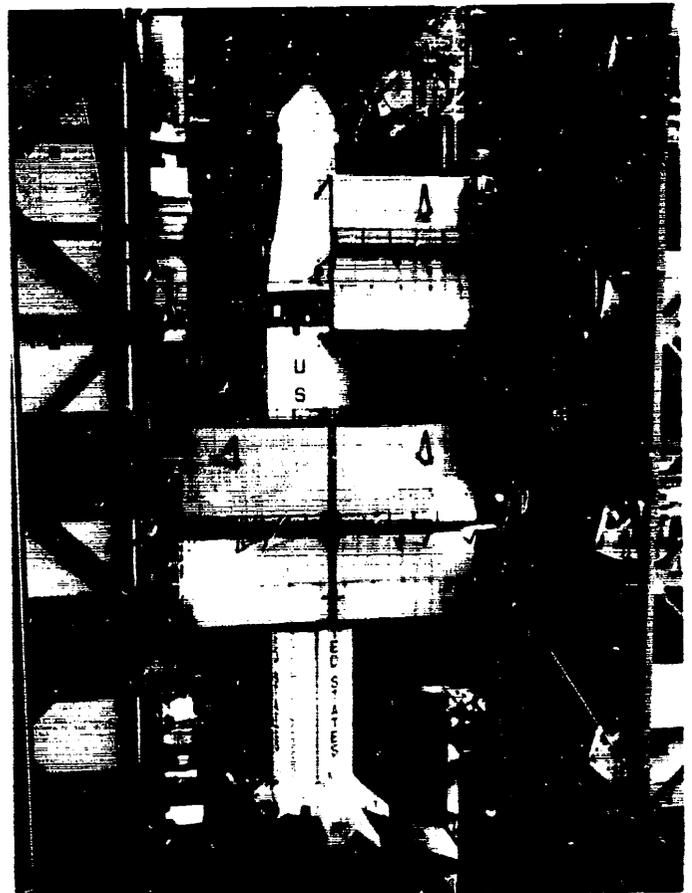
February 1973



**OWS, AM, MDA & ATM SYSTEMS ENGR  
MOCKUPS IN BLDG 4619**

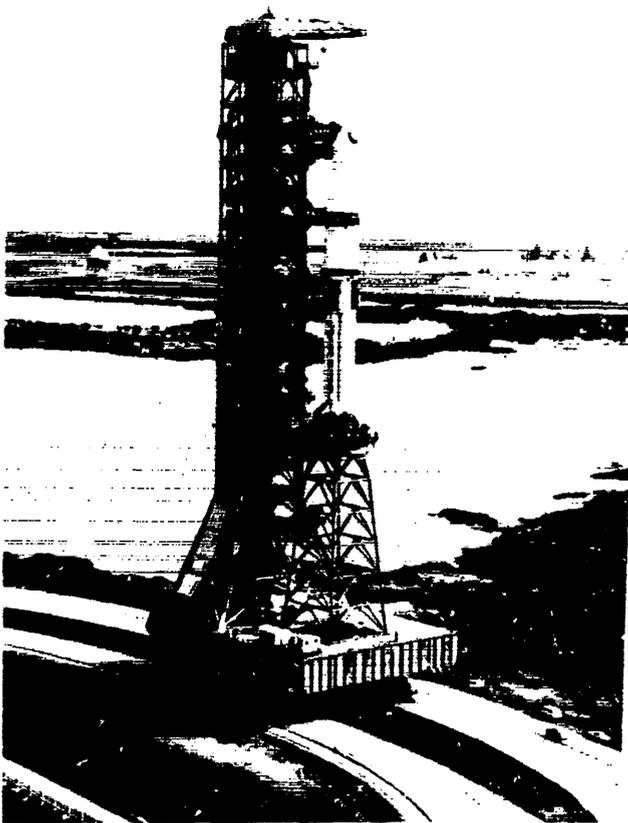


**MATING CSM 116 TO LAUNCH VEHICLE  
SATURN IB-206**



**SL-2 IN VEHICLE ASSEMBLY BUILDING**

March 1973



**ROLL OUT OF SL-2**

**MARCH 1:** In the MSFC Skylab monthly Program Review, Dr. Rocco Petrone established the requirement for an MSFC flight hardware integrity review. The review activity was to assure the integrity of MSFC-developed hardware by reviewing in depth, at the contractors' facilities and MSFC, the specifications, design and design changes, failures and test results of critical hardware components and systems associated with the activation sequences. The activity was scheduled to be completed before the MSFC Pre-FRR meeting in mid-April [278].

**MARCH 1:** The second of a series of Skylab orbital operations simulations, begun on February 26, 1973, were conducted at Johnson Space Center (JSC) (formerly Manned Space Center). These represented mission days 138, 139, and 140. MSFC supported these simulations through active participation in JSC's Flight Operations Management Room (FOMR), MSFC's Huntsville Operations Support Center (HOSC), and in other mission support groups. A major effort simulating the Skylab mission activities was planned from February until launch to work out mission support activities and to prepare all elements for the real time mission support [279].

**MARCH:** The OWS backup unit was nearing completion of installations of hardware and verification at MDAC-W in preparation for Skylab mission support [280].

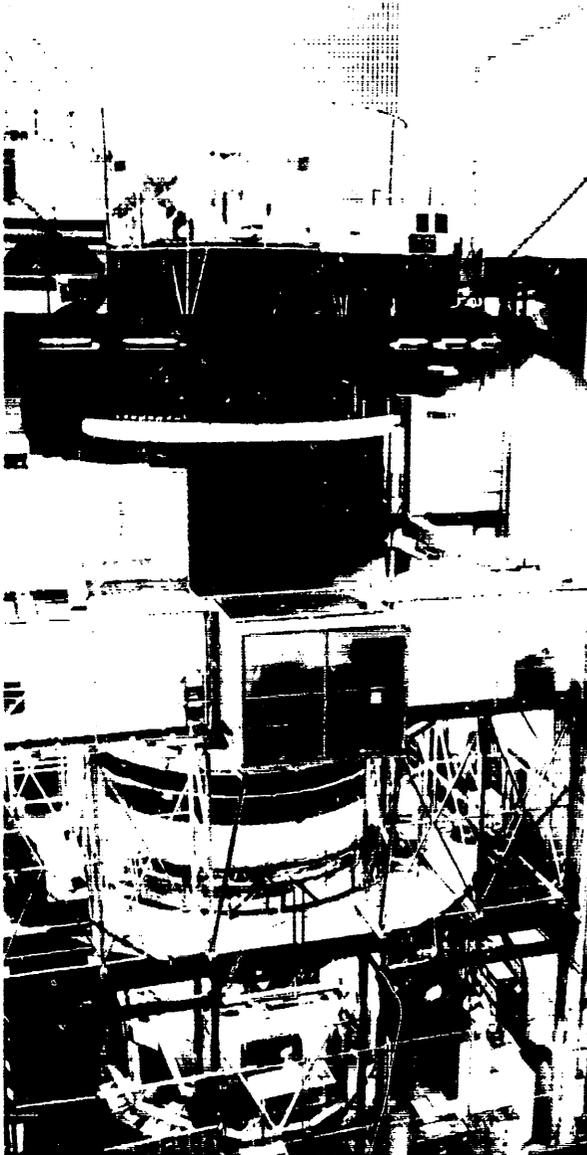
**MARCH:** While flight hardware checkout activities were underway at KSC, simulations at JSC and other activities elsewhere were in full preparation for the first Skylab mission. Astronauts Charles Conrad, Jr., Commander; Paul J. Weitz, Pilot; and Dr. Joseph P. Kerwin, Science Pilot, were busy training in the OWS, AM/MDA, ATM, and CM trainers at JSC and the Neutral Buoyancy Simulator at MSFC [281].

**MARCH 25:** The flight hardware successfully completed the first total mission operations sequence during the Mission Simulation and Flight Readiness Test. This activity included the SL-2 astronaut crew participation in the simulated launches of SL-1 and SL-2, mission activation and operation, deactivation, data dump, and power down [282].

**MARCH 30:** A major launch vehicle milestone was met when the launch vehicle flight readiness test was successfully completed at KSC [283].

April 1973

Program Manager, followed by a series of presentations by Skylab specialists on the various systems, experiments, and research efforts connected with the Skylab missions. Included in the two days of activities were tours of the High Fidelity Mockups and Neutral Buoyancy Simulator. Of particular interest among the displays were hardware exhibits of experiments proposed by high school students. On April 4 NASA also announced firm launch dates for SL-1 and SL-2 as May 14 and 15, 1973, respectively [284].



**INSTALLATIONS IN OWS BACKUP UNIT  
AT MDAC-W**

APRIL 4 & 5: News reporters and commentators from throughout the United States and several foreign countries attended a series of Skylab press briefings at MSFC. The sixty visitors were given an overview of the Skylab project by Rocco Petrone, Center Director, and Leland Belew, MSFC Skylab

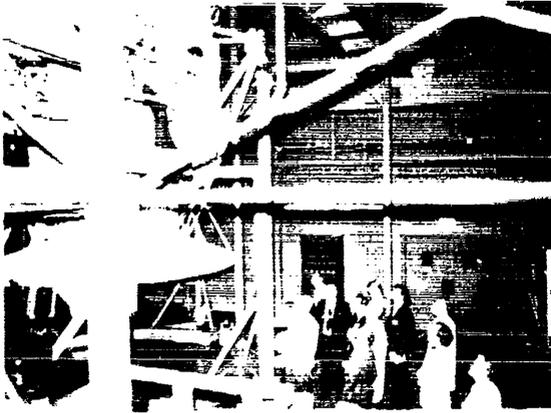


**MSFC SKYLAB PRESS CONFERENCE  
BRIEFING**



**REPORTERS FILMING NEUTRAL  
BUOYANCY EXERCISE DURING  
PRESS CONFERENCE**

April 1973



**REPORTERS IN ENGINEERING MOCKUP  
AREA DURING PRESS CONFERENCE**

APRIL 5: The last Student Experiment flight hardware (ED31, Bacteria and Spores, for the SL-1 and SL-2 missions) was delivered to KSC. The 25 experiments selected to fly in the Skylab mission were [285].



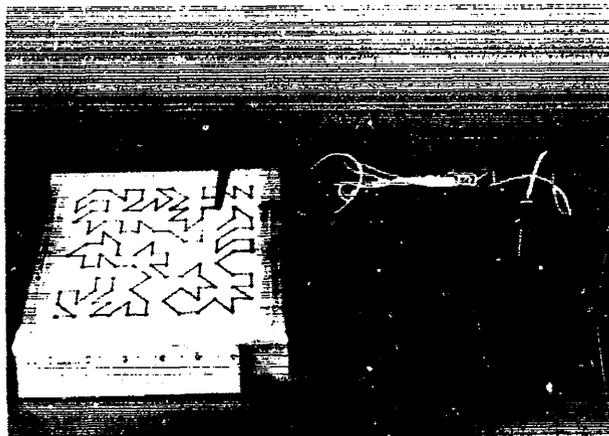
**SKYLAB STUDENT EXPERIMENTERS**

(Left to Right, rear row - Robert L. Staible, Keith I. Stein, Joel G. Wordenkemper and Joe B. Zmolek, third row - Judith S. Miles, Obayf A. Pettz, Terry C. Gust, Joe W. Rehy, Donald W. Schlack, Neal W. Shannon and Kirk M. Sherhart, second row - Alison Hopfield, Kathy L. Jackson, Roger C. Johnston, Jeanne L. Loventhal, Keith D. McGee, Todd A. Meator and Gregory A. Merkel, first row - Daniel C. Baender, Kent M. Brandt, Vincent W. Converse, Troy A. Crites, W. Brian Dunlap, John C. Hamilton and James E. Healy.)



**STUDENT EXPERIMENT ED52 WEB  
FORMATION**

(Student Judith Miles seated next to Dr. Gause  
NASA Advisor.)

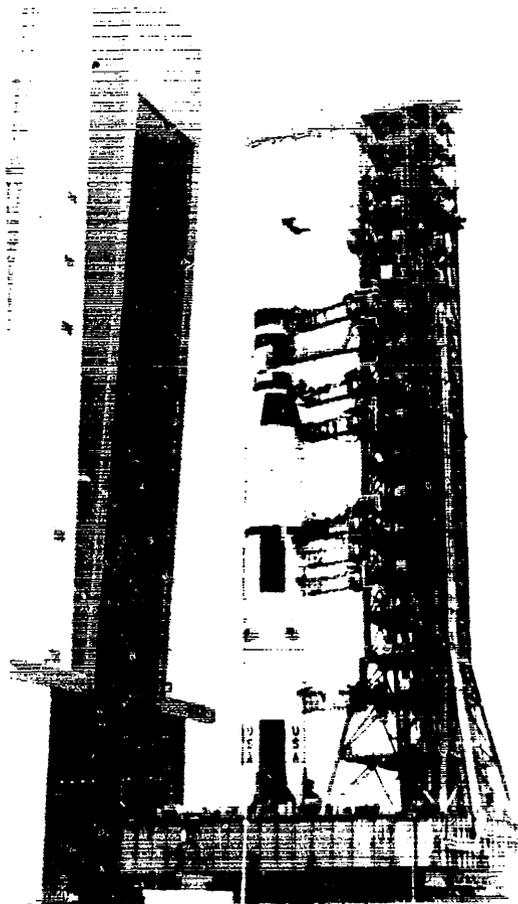


### STUDENT EXPERIMENT ED41 MOTOR SENSORY PERFORMANCE

**APRIL 9 & 10:** The MSFC Pre-FRR was conducted in a two day meeting at MSFC. Closeout of actions from the Cluster DCR in October 1972 was covered, and results of the MSFC flight hardware integrity review along with test and documentation status were reviewed in preparation for the SL-1 and SL-2 FRR scheduled for April 18-20, 1973 [286].

**APRIL 16:** One of the last major milestones prior to launch occurred at 7 a.m. EST, when the United States first space station, SL-1, left the VAB and started roll out to Launch Complex 39A. Final checkout would be continued on the pad until the May 14 launch. The Skylab payload mounted on the first two stages of a giant Saturn V rocket would be launched into a 270 statute mile orbit. Astronauts Charles Conrad, Jr., Paul J. Weitz, and Dr. Joseph P. Kerwin aboard a Saturn IB rocket would be launched into space on May 15 for rendezvous and docking to the Skylab [287].

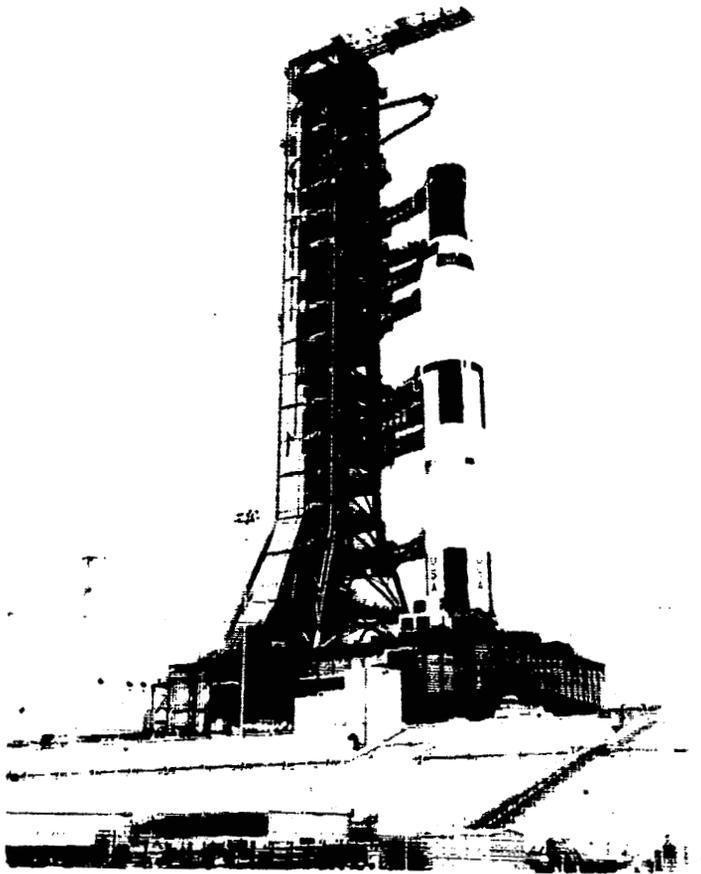
**APRIL 18-20:** The final NASA top management review and approval of the launch



### ROLLOUT OF SL-1 AT KSC

and mission readiness of SL-1 and SL-2 missions were completed in the Flight Readiness Review at KSC. Items covered in the review ranged from modules' and launch vehicles' readiness to missions and operations support. Launch time for SL 1 would be 12:30 p.m. CDT, May 14, and SL 2 for 12:00 p.m. CDT May 15 [288].

**April 1973**



**SL-1 ON LAUNCH PAD 39A AT KSC**

## LIST OF ABBREVIATIONS AND ACRONYMS

<b>AAP</b>	<b>Apollo Applications Program</b>
<b>ACE</b>	<b>Automatic Checkout Equipment</b>
<b>AM</b>	<b>Airlock Module</b>
<b>AS&amp;E</b>	<b>American Science and Engineering</b>
<b>ATM</b>	<b>Apollo Telescope Mount</b>
<b>CDDT</b>	<b>Countdown Demonstration Test</b>
<b>CDR</b>	<b>Critical Design Review</b>
<b>C<sup>2</sup>F<sup>2</sup></b>	<b>Crew Compartment Fit and Function Test</b>
<b>CM</b>	<b>Command Module</b>
<b>CMG</b>	<b>Control Moment Gyro</b>
<b>CSM</b>	<b>Command/Service Module</b>
<b>DA</b>	<b>Deployment Assembly</b>
<b>ECS</b>	<b>Environmental Control System</b>
<b>EPCS</b>	<b>Experiment Pointing and Control Subsystem</b>
<b>EPS</b>	<b>Electrical Power System</b>
<b>EREP</b>	<b>Earth Resources Experiment Package</b>
<b>EVA</b>	<b>Extravehicular Activity</b>
<b>EVA/IVA</b>	<b>Extravehicular and Intravehicular Activity</b>
<b>FAS</b>	<b>Fixed Airlock Shroud</b>
<b>GSE</b>	<b>Ground Support Equipment</b>
<b>GSFC</b>	<b>Goddard Space Flight Center</b>
<b>HAO</b>	<b>High Altitude Observatory</b>
<b>HCO</b>	<b>Harvard College Observatory</b>

<b>HEAO</b>	<b>High Energy Astronomy Observatory</b>
<b>HOSC</b>	<b>Huntsville Operation Support Center</b>
<b>IU</b>	<b>Instrument Unit</b>
<b>IVA</b>	<b>Intravehicular Activity</b>
<b>KSC</b>	<b>John F. Kennedy Space Center</b>
<b>LBNP</b>	<b>Lower Body Negative Pressure</b>
<b>LH<sub>2</sub></b>	<b>Liquid Hydrogen</b>
<b>LM-A</b>	<b>Lunar Module Ascent Stage</b>
<b>LOX</b>	<b>Liquid Oxygen</b>
<b>LV</b>	<b>Launch Vehicle</b>
<b>MDA</b>	<b>Multiple Docking Adapter</b>
<b>MDAC-E</b>	<b>McDonnell Douglas Aircraft Corporation, Eastern Division</b>
<b>MDAC-W</b>	<b>McDonnell Douglas Aircraft Corporation, Western Division</b>
<b>MMC</b>	<b>Martin Marietta Corporation</b>
<b>MSC</b>	<b>Manned Spacecraft Center (Now Lyndon B. Johnson Space Center)</b>
<b>MSFC</b>	<b>George C. Marshall Space Flight Center</b>
<b>n.mi.</b>	<b>Nautical Mile</b>
<b>NRL</b>	<b>Naval Research Laboratory</b>
<b>OART</b>	<b>Office of Advanced Research and Technology</b>
<b>O&amp;C</b>	<b>Operations and Checkout Building</b>
<b>OSSA</b>	<b>Office of Space Science and Applications</b>
<b>OWS</b>	<b>Orbital Workshop</b>
<b>PDR</b>	<b>Preliminary Design Review</b>
<b>PS</b>	<b>Payload Shroud</b>
<b>SA</b>	<b>Solar Array</b>

<b>SAL</b>	<b>Scientific Airlock</b>
<b>SL</b>	<b>Skylab</b>
<b>SLA</b>	<b>Spacecraft-Lunar Module Adapter</b>
<b>SSESM</b>	<b>Spent Stage Experiment Support Module</b>
<b>STS</b>	<b>Structural Transition Section</b>
<b>SWS</b>	<b>Saturn Workshop</b>
<b>TACS</b>	<b>Thruster Attitude Control Subsystem</b>
<b>UV</b>	<b>Ultraviolet</b>
<b>VAB</b>	<b>Vehicle Assembly Building</b>

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